11.0 Opinion of Probable Costs

11.0 Opinion of Probable Costs

Opinions of probable capital and annual costs were prepared for the water transfer system facilities anticipated to be required for each corridor. For Corridor 1A, separate cost estimates were prepared for increasing the capacity of the existing Colorado River Aqueduct (CRA) facilities to result in additional transfer capability of about 200,000 acre-feet (Stage 1), and for construction of new parallel facilities with hydraulic capacity corresponding to an annual transfer volume of 300,000 acre-feet (Stage 2). Separate cost estimates were prepared for Corridors 3A, 3B, 5A, and 5C for annual transfer volumes of 300,000, 400,000, and 500,000 acre-feet.

In accordance with the purpose of this study, the opinions of probable costs provided in this section define an estimated range of costs for facilities to transfer water from the Imperial Irrigation District to the San Diego County Water Authority. The cost opinions should be used for the exclusive purpose of determining whether additional investment in more detailed evaluations is warranted.

This section describes the basis of the cost estimates. All estimates are in 1996 dollars. Cost summary tables providing cost breakdowns by major component for each transfer volume considered, as well as cost summary tables for each corridor are provided at the end of this section

11.1 Estimated Capital Costs for Corridor 1A

11.1.1 Stage 1--Colorado River Aqueduct Expansion

Estimated costs for required modifications to existing components of the CRA were prepared based on the concept designs and layouts provided in Section 7.0. Cost estimates were based on estimated quantities and unit costs for major civil/structural work items.

Estimated construction costs for expansion of the existing system are provided in the summary table at the end of this section. The estimated cost per linear foot of the various project features broken down by major construction operation are provided in Tables 11-1 through 11-7. Minor construction items which do not impact the cost significantly are included in the contingency percentage.

Raise Existing Canals. The unit price for concrete removal includes sawcutting the canal liner and disposing of the debris offsite. Since there will not be any significant excavation required to raise the canal liner, the embankment will have to be imported from offsite sources. The embankment behind the liner would be constructed of selected

Table 11-1
Unit Cost Summary--Casa Loma Siphon

Item	Description	Unit	Qty/LF	Unit Price	Cost ($/LF)
1	Excavation	CY	26	3.0	78.0
2	Select Backfill	CY	23	11.1	255.3
3	10 Foot RCP	LF	1	710	710.0
4	Chain Link Fence	CF	2	10.5	21.0
	Total				1,064.3

Table 11-2
Cost Summary--Replace Cut-and-Cover Conduits With Canal

Item	Description	Unit	Quantity	Unit Price	Cost ($1,000)
1	Excavation Common	CY	3,970,000	3	11,910
2	Rock Excavation	CY	3,970,000	20	79,400
3	Disposal of Exc. Mat.	CY	5,050,000	7.5	37,875
4	Remove and Dispose Concrete	CY	37,900	38.9	1,474
5	Embankment from Excavation	CY	2,743,700	1.3	3,567
6	Concrete	SY	2,962,700	28	82,956
7	Chain Link Fence	LF	504,680	10.5	5,299
	Total				222,481

Table 11-3
Unit Cost Summary--Raise Existing 20 Foot Canals

Item	Description	Unit	Quantity	Unit Price	Cost ($1,000)
1	Excavation	CY	432,400	3.0	1,297
2	Remove and Dispose Concrete	CY	16,600	38.9	646
3	Select Embankment	CY	336,600	14.8	4,982
4	Borrow Embankment	CY	2,422,900	9.5	23,018
5	Concrete Lining	SY	339,900	14.0	4,759
6	Chain Link Fence	LF	665,300	10.5	6,986
	Total				41,688

Table 11-4
Unit Cost Summary--Modify Siphon Transition Structures

Item	Description	Unit	Quantity	Unit Price	Cost ($)
1	Excavation	CY	800	10.0	8,000
2	Structural Backfill	CY	160	11.1	1,776
3	Remove Concrete	CY	102.0	83.50	8,517
4	Reinforced Concrete	CY	342	700	239,400
	Total				257,693

Table 11-5
Unit Cost Summary--Add Barrel to Siphons*

Item	Description	Unit	Quantity	Unit Price	Cost ($/LF)
1	Excavation Common	CY	12	3.0	36.0
2	Rock Excavation	CY	11	20	220.0
3	Select Backfill	CY	20	11.1	222.0
4	8'-6" RCP	LF	1	615	615.0
	Total				1,093.0

*Does not include siphons requiring complete replacement due to excessive additional head.

Table 11-6
Unit Cost Summary--Reconstruct Siphons--Type 11

Item	Description	Unit	Quantity	Unit Price	Cost ($/LF)
1	Excavation	CY	46.0	3	138.0
2	Remove and Dispose Reinforced Concrete	CY	2.5	83.50	208 8
3	Select Backfill	CY	37.0	11 1	410.7
4	Cast-in-Place Concrete	CY	3.0	700	2,100.0
	Total				2,857.5

Table 11-7
Unit Cost Summary--Reconstruct Siphons--Type 12

Item	Description	Unit	Qty/LF	Unit Price	Cost ($/LF)
1	Excavation	CY	59.0	3	177.0
2	Remove and Dispose Reinforced Concrete	CY	3.25	83.5	271.4
3	Select Backfill	CY	49	11.1	543.9
4	13'-0" RCP	LF	1	1,020	1,020.0
	Total				2,012.3

granular material to allow free draining of water accumulated behind the liner. The concrete liner would be placed and finished by machine and joints would be sawcut and sealed in the green concrete to control cracking. Concrete debris would be removed to an authorized disposal site within 5 miles distance.

Replace Cut-and-Cover Conduit With Canals. The excavation volumes have been conservatively divided equally between rock and common because the cut-and-cover conduits that the canals replace traverse very rough terrain downstream of Hinds Pumping Station. Excavated material in excess of the volumes required to build maintenance roads would have to be removed and disposed offsite. The concrete liner for the new canal will have the same dimensions as the existing canals.

Add Barrel to Siphons. Because the siphons traverse deep ravines, it is likely that excavation would be partly in rock and in common material. The other major component of the unit cost of siphons is the cost of the reinforced concrete pipe.

Unit prices for excavation differentiate between rock and common excavation, and take into account the disposal of excess excavated material in authorized disposal sites assumed to be available within distances not exceeding 5 miles. Material excavated for canal construction has been utilized where possible for the construction of embankments for maintenance roads. However, selected embankment material has been used to raise the concrete lining of existing canals.

Water Treatment. Capital costs for water treatment and brine disposal facilities were estimated based on the water quality characteristics and concept designs discussed in Section 6.0. Treatment facility costs were estimated based on construction of reverse osmosis facilities at or near existing water treatment plants located on the west side of the water transfer system. Blended water quality would be 500 mg/l TDS. For Corridor 1A, water treatment costs are based on an estimated unit construction cost of $570/AF of delivered water. Accounting for brine disposal requirements, the annual transfer of 200,000 acre-feet of water will result in an estimated annual deliverable water volume of 181,400 acre-feet.

Land Acquisition. Land acquisition costs for tunnels (required for Case 2 only as described in Section 7.1.2) were based on an average surface easement width of 50 feet. Land acquisition costs for all other system components were based on an average right-of-way width of 150 feet.

Stage 1 Development Cost Range. The costs presented in the table at the end of this section for Stage 1 development represent a best case scenario (Case 1 in Subsection 7.1.2) in terms of existing CRA hydraulic conditions and the modifications considered for the various components of the CRA to achieve the additional annual conveyance

capacity of 200,000 AF. For this best case scenario, no modifications are considered to be required to the existing pumping plants. The relationships between total pumping plant discharge and net head have not been established. Therefore, the actual capability of the pumping plants to deliver the required flows under somewhat greater total head conditions than presently exist is unknown. A potential consequence may be a reduced transfer capability below the desired 200,000 AF.

Under less favorable CRA hydraulic conditions (Case 2 in Subsection 7.1.2), the ability of the Iron Mountain and Hinds Pumping Plants to deliver the increased flows is doubtful due to even greater total head conditions. For these less favorable hydraulic conditions, construction of a new 18.3 mile long tunnel parallel to the Coachella Tunnel located downstream from Hinds, and construction of a new 8.3 mile long tunnel parallel to the Iron Mountain Tunnel located downstream from the Iron Mountain Pumping Plant were considered to be required to reduce total pumping head. Additionally, construction of a new 6 mile long tunnel parallel to the Whipple Mountain Tunnel located downstream from Copper Basin Reservoir was considered to be required to eliminate the need to increase the water surface elevation within Copper Basin Reservoir. The estimated total capital cost for these tunnels is approximately $540 million. The addition of this cost to the best case scenario costs is considered to represent the likely upper limit of Stage 1 development costs. The breakdown of total capital costs for the additional tunnels is as follows:

Item	Cost ($)
Tunnels: 172,128 LF (32.6 miles) x $2,000/LF	344,256,000
Land Acquisition: 200 acre x $10,000/acre	2,000,000
Subtotal	346,256,000
Contingency at 35 percent	121,190,000
Subtotal	467,446,000
Indirects at 15 percent	70,117,000
Total Estimated Capital Cost	537,563,000
	≅$540 million

The wide range of estimated costs for Stage 1 development reflects the cost sensitivity of the large and complex CRA system to existing hydraulic conditions. As a result, additional design evaluations would be appropriate to refine the system hydraulic conditions and estimated Stage 1 development costs. A reduced annual transfer capability should also be evaluated. Clearly, the most cost-effective system would maximize annual transfer capability while minimizing the costs for modifications to the CRA. Therefore,

any additional evaluations should compare the costs for systems having reduced transfer capabillity with the incremental costs associated with providing the full 200,000 AF.

11.1.2 Stage 2--New Parallel System

Estimated costs for new system components were prepared based on the concept designs and layouts provided in Section 7.0. Cost estimates for civil/structural work items associated with canals, reinforced concrete pipelines, and siphon facilities were based on estimated quantities and unit costs. The estimated costs for tunnels were prepared on a unit cost basis based on the tunnel cost estimates prepared for the other corridors and the expected tunneling conditions and construction methods for tunnels parallel to the CRA. Cost estimates for the pumping plants were based on an overall unit cost for installed pumping power demand at each plant. Land acquisition costs were based on the same right-of-way widths indicated for Stage 1 development and are included in the Stage 1 estimated costs.

Capital costs for water treatment and brine disposal facilities were estimated based on the water quality characteristics and concept designs discussed in Section 6.0. For Corridor 1A, water treatment costs are based on an estimated unit construction cost of $570/AF of delivered water. Accounting for brine disposal requirements, the annual transfer of 300,000 acre-feet of water will result in an estimated annual deliverable water volume of 272,100 acre-feet.

The estimated cost per linear foot of the various project features broken down by major construction operation are provided in Tables 11-8 through 11-12. A summary of total capital cost for this alternative is provided in the cost summary table at the end of this section.

11.2 Estimated Capital Costs for Corridors 3A, 3B, 5A, and 5C

11.2.1 Canals

Unit costs for the principal items of work provided the basis for estimated construction costs. These unit costs were derived from experience with similar work and, as appropriate, were increased to reflect access, right-of-way restrictions, and distance to the project area. The estimated capital costs do not include the preparation of environmental compliance documentation or the implementation of environmental mitigation measures.

Estimated costs for concrete-lined canals are based on quantity estimates of the principal pay items and estimated unit costs. Estimated canal costs per linear foot are summarized in Table 11-13.

Table 11-8
Unit Cost Summary--San Diego & Casa Loma Canals

Item	Description	Unit	Qty/LF	Unit Price	Cost ($/LF)
1	Excavation	CY	7.6	10	76.0
2	Select Embankment	CY	1.6	10.5	16.8
3	Embankment from Excavation	CY	8.0	1.3	10.4
4	Concrete Lining	SY	4.0	7.0	28.0
5	Chain Link Fence	LF	1.0	10.0	10.0
	Total				141.2

Table 11-9
Unit Cost Summary--Canals Upstream of Hines

Item	Description	Unit	Qty/LF	Unit Price	Cost ($/LF)
1	Rock Excavation	CY	3.0	17	51.0
2	Common Excavation	CY	3.6	10	36.0
3	Embankment from Excavation	CY	3.0	1.3	3.9
4	Borrow Embankment	CY	6.6	6.35	41.9
5	Concrete Liner	SY	3.7	7.0	25.9
6	Chain Link Fence	LF	1.0	10.0	10.0
	Total				168.7

Table 11-10
Unit Cost Summary--Cut-and-Cover RCP

Item	Description	Unit	Qty/LF	Unit Price	Cost ($/LF)
1	Rock Excavation	CY	13	17	221
2	Common Excavation	CY	14	10	140
3	Structural Backfill	CY	22	11	242
4	11 foot RCP	LF	1	820	820
	Total				1,423

Table 11-11
Unit Cost Summary--New Siphon Transitions

Item	Description	Unit	Qty/LF	Unit Price	Cost ($)
1	Excavation	CY	1,190	10	11,900
2	Structural Backfill	CY	680	11.1	7,548
3	Reinforced Concrete	CY	200	700	140,000
	Total				159,448

Table 11-12
Unit Cost Summary-- Siphon Barrels

Item	Description	Unit	Qty/LF	Unit Price	Cost ($/LF)
1	Excavation	CY	20	10	200
2	Select Backfill	CY	15	11.1	166.5
3	84 inch RCP	LF	2	510	1,020
	Total				1,386.5

Table 11-13
Estimated Construction Cost per Linear Foot of Concrete-Lined Canal

Item	Unit Cost, $	Unit	456 cfs Capacity		608 cfs Capacity		760 cfs Capacity	
			Quantity	Cost, $	Quantity	Cost, $	Quantity	Cost, $
Excavation	3.08	CY	4.02	12.38	4.8	14.72	4.89	15.06
Compacted Embankment	1.23	CY	0.40	0.49	0.62	0.76	0.74	0.91
Concrete Lining	7.02	SY	3.96	27.80	4.36	30.61	4.56	32.01
Chain Link Fence	10.00	LF	2.0	20.00	2.0	20.00	2.0	20.00
Total Cost				60.67		66.09		67.98

Estimated costs for inverted siphons, siphon undercrossings, and the turnout structure are also based on quantity estimates and estimated unit costs. Land acquisition costs for canals were based on an average right-of-way width of 150 feet.

11.2.2 Pipelines

Pipe. The welded steel pipe has been categorized by 1/8 inch increments. The governing pipe wall thicknesses were determined as described in Section 7.0. Unit costs were quoted by Ameron, Inc. and Northwest Pipe and include tape wrap coating overlaid by a protective cement mortar coating, delivery to the site, and a weighted average for special pipe pieces.

Installation and Trenching. The cost for pipe installation includes handling of the pipe and welding of all joints. Costs for trench and pipe installation include dewatering, location and support of existing utilities, trench excavation, removal of excess material, bedding, select backfill, and shoring. All excavation and backfill quantities are based on calculated volumes and probable construction costs of Pipeline 5EII. All unit costs have been adjusted from the unit costs of the Inland Feeder pipeline.

Accessories/Specials. Accessories and specials include appurtenances and crossings. Cost estimates for appurtenances are based on the average cost per mile of appurtenances from Pipeline 5EII. Appurtenances include air release and vacuum valves, blowoffs, pump wells, manholes, cathodic protection, and fiber optics. The crossings include fault, highway, railroad, and river or stream. These costs are based on unit costs from Pipeline 5EII, with the exception of fault crossings (5EII does not cross faults).

Surface/Utilities. Mobilization, clearing, and hydroseeding costs are included and based on a weighted average from the cost per mile from the Inland Feeder pipeline and Pipeline 5EII.

Land Acquisition. Land acquisition costs for pipelines were estimated based on an average right-of-way width of 130 feet.

11.2.3 Tunnels

Conceptual level estimates of construction cost and schedules were prepared for the various tunnel reaches within each of the alternative corridors. These tunnel cost and schedule estimates were prepared by our consultant, Mr. P. E. Sperry. The following section discusses the estimating methodology and the assumptions used to develop the estimates. The cost and schedule estimates prepared by Mr. Sperry are presented in Appendix A along with an explanation of the tunneling cost spreadsheets.

The tunnels on each corridor were divided into logical construction contracts and the construction cost was then prepared for each contract. A typical contract includes a tunnel segment which is constructed portal to portal such as the tunnel on Corridor 3A between I-15 and the Diversion Structure, or the tunnel on Corridor 5A between the San Diego River and San Vicente Reservoir. Other contracts for the longer tunnels include the construction of the access shaft and construction of two tunnels extending in opposite directions from the shaft to a point midway between the next shaft or portal, or in some cases the development of a portal and construction of the tunnel to a midpoint to the first shaft. The division of each contract is shown on the Profile and Geotechnical Summary figures for Corridors 3A, 3B, and 5A, which are provided in Section 7.0.

Due to the length of the tunnels and the required working space for ventilation ducts, pipes to pump out groundwater water inflows and room for muck railcars, a 12 foot minimum excavated diameter was selected. All tunnels were assumed to have a minimum finished diameter of 9.5 feet. Costs were then prepared for two alternative lining conditions. The first condition is to use the unlined tunnel where rock quality is considered to be sufficiently good and the cover over the tunnel is sufficient to prevent hydraulic jacking, use a 12 inch thick unreinforced concrete lining in sections where the rock quality is considered to be poor (e.g., through major fault zones), and use steel lining where hydraulic jacking is considered to be a potential problem. Hydraulic jacking was considered to be an issue wherever the hydraulic grade line was greater than the rock cover (e.g., at least 1 foot of rock cover needed for each foot of head). The second condition was to prepare the cost estimate assuming the entire tunnel would be lined with 12 inches of unreinforced concrete except where hydraulic jacking was an issue, in which case a steel lining was used. These various lined and unlined conditions result in three finished tunnel diameters, 12 foot for an unlined tunnel, 10 foot for a concrete-lined tunnel, and 9.5 foot for a steel-lined tunnel.

Using this approach, tunnel diameter is the same for each transfer volume considered and is based on the 12 foot minimum excavated diameter. As a result, tunnel costs are the same for each annual transfer volume.

A basic parameter for developing tunnel construction cost and schedule estimates is the rate of advance of the tunnel excavation. For the relatively short sections of tunnel which would be excavated using drill-and-blast construction methods, such as starter tunnels at portals and at the bottom of shafts, advance rates were assumed on the basis of numerous case histories. For the remaining long reaches of tunnel which would be excavated with a TBM, a complete "contractor-type" estimate was prepared for a 20,000 foot long tunnel excavated from a portal and placing concrete or steel lining from a portal. The

advance rates used for this estimate were based on case histories for similar length tunnels and assumed no adverse geotechnical conditions. In order to derive an advance rate for each of the tunnel segments on the various corridors, appropriate delay and cost factors were applied to the basic cost and schedule estimate to account for the construction conditions and anticipated geotechnical conditions. These conditions included the following:

- One tunnel driven from a shaft.
- Two tunnels driven from a shaft.
- Driving the tunnel on a minor downgrade (water must be pumped from heading).
- Driving the tunnel on a 3 percent downgrade.
- Driving the tunnel on a 3 percent upgrade.
- Driving the tunnel on a 5 percent upgrade.
- Installing spot rock bolts and channel steel (average two bolts per 100 feet of tunnel).
- Installing pattern rock bolts (two bolts, 4 feet on center with wire fabric and shotcrete).
- Installing steel sets 4 feet on center (4WF 13# ribs with steel mesh lagging).
- Installing heavy steel sets 4 feet on center (6WF 20# ribs with lagging).
- Installing heavy steel sets 2 feet on center (6WF 20# ribs with lagging).
- Handling medium groundwater inflows (100 to 700 gpm).
- Handling high groundwater inflows (700 to 2,500 gpm).
- Running a drill probe ahead of the TBM to check for groundwater.
- Stopping to grout ahead of the TBM to control groundwater inflows.
- Handling high ambient ground temperatures (air conditioning at heading).
- Generating onsite power at remote shaft or portal locations.
- Offsite muck disposal.

Based on the results of the geologic characterizations for the alternative tunnel corridors, the anticipated ground conditions, groundwater inflows, support requirements, lining requirements, need for grouting, etc., have been summarized on the Profile and Geotechnical Summary figures included in Section 7.0. The most significant delay to TBM advance was due to anticipated high groundwater inflows and the need to stop the TBM to advance a probe hole and to grout the rock mass to control groundwater inflows. The need to install steel sets also caused significant delays to the TBM advance rate. Shaft and portal sites which were considered to require onsite generated power, offsite

muck disposal, or a well drilled to provide water are summarized in Table 11-14. These table values were based on review of U.S.G.S. 7-1/2 minute topographic maps and the portal or shaft location relative to existing developed areas where water and power may be available. If a shaft or portal were adjacent to an undeveloped canyon of sufficient size to contain the generated tunnel muck, then onsite muck disposal was considered. If the portal or shaft was in a developed area or in Anza Borrego State Park, offsite muck disposal was considered to be required.

The costs for shaft excavation and lining was based on a cost estimate prepared for the 3,215 foot deep intake shaft at the Mt. Hope Pumped Storage Project. These costs were then modified for current California labor rates and efficiency. All shafts were assumed to be excavated to a diameter of 29 feet and lined with concrete to a finished diameter of 26 feet. The shafts were also assumed to be constructed using drill-and-blast construction methods. All work underground was assumed to consist of three 8 hour shifts per day, five days a week, with a maintenance shift on Saturday.

The costs for portals, shafts and tunnels for each contract on a particular corridor are presented in Table 11-15. These costs include both partially lined tunnels (unlined where possible), and fully lined tunnels. For purposes of the feasibility level evaluations, the estimated costs for partially lined tunnels were used as basis for the tunnel cost estimates. The costs presented are in 1996 dollars and do not include any contingencies.

Land acquisition costs for tunnels were based on an average surface easement width of 50 feet.

11.2.4 Pumping Plants

Estimated costs for pumping plants were prepared based on the concept designs and layouts provided in Section 7.0. Cost estimates were based on estimated quantities and unit costs for the major civil/structural work items and estimates of installed equipment costs for electrical and mechanical equipment.

11.2.5 Power Generating/Pressure Control Facilities

Estimated costs for power generating/pressure control facilities were prepared based on the concept designs and layouts provided in Section 7.0. For the surface powerhouse facilities, cost estimates were based on estimated quantities and unit costs for the major civil/structural work items and estimates of installed equipment costs for electrical and mechanical equipment. Estimated costs for the underground powerhouse associated with Corridor 3B were based on overall unit cost for installed capacity.

Table 11-14
Tunnel Portal and Shaft Utility Availability

CORRIDOR 3A: BORREGO SPRINGS TO I-15				
TUNNEL CORRIDOR IDENTIFICATION	DESCRIPTION AND MILEPOST	WATER AVAILABLE	ONSITE MUCK DISPOSAL	POWER AVAILABLE
3A	PORTAL 50.3	YES	NO	YES
3A	SHAFT 58.0	NO	NO	YES
3A	SHAFT 65.0	NO	YES	YES
3A	SHAFT 72.6	NO	YES	NO
3A	SHAFT 80.2	NO	YES	NO
3A	SHAFT 87.8	YES	NO	YES
3A	PORTAL 91.8	YES	NO	YES
CORRIDOR 3A: I-15 TO DIVERSION STRUCTURE				
TUNNEL CORRIDOR IDENTIFICATION	DESCRIPTION AND MILEPOST	WATER AVAILABLE	ONSITE MUCK DISPOSAL	POWER AVAILABLE
3A	PORTAL 92.0	YES	NO	YES
3A	PORTAL 94.2	YES	NO	YES
CORRIDOR 3B: SENTENAC CANYON				
TUNNEL SEGMENT IDENTIFICATION	DESCRIPTION AND MILEPOST	WATER AVAILABLE	ONSITE MUCK DISPOSAL	POWER AVAILABLE
3B	PORTAL 51.7	NO	NO	NO
3B	PORTAL 53.5	NO	NO	NO
CORRIDOR 3B: BANNER GRADE TO SAN VICENTE RESERVOIR				
TUNNEL CORRIDOR IDENTIFICATION	DESCRIPTION AND MILEPOST	WATER AVAILABLE	ONSITE MUCK DISPOSAL	POWER AVAILABLE
3B	PORTAL 60.0	NO	NO	NO
3B	SHAFT 68.6	NO	YES	NO
3B	SHAFT 76.4	NO	NO	NO
3B	PORTAL 84.2	YES	NO	NO
CORRIDOR 5A: TIERRA BLANCA MOUNTAINS TO CHOCOLATE CANYON				
TUNNEL CORRIDOR IDENTIFICATION	DESCRIPTION AND MILEPOST	WATER AVAILABLE	ONSITE MUCK DISPOSAL	POWER AVAILABLE
5A	PORTAL 29.9	NO	NO	NO
5A	SHAFT 37.0	NO	YES	NO
5A	SHAFT 45.4	NO	NO	NO
5A	SHAFT 52.0	NO	YES	YES
5A	SHAFT 58.1	NO	NO	NO
5A	PORTAL 63.8	NO	NO	NO
CORRIDOR 5A: CHOCOLATE CANYON TO SAN DIEGO RIVER				
TUNNEL CORRIDOR IDENTIFICATION	DESCRIPTION AND MILEPOST	WATER AVAILABLE	ONSITE MUCK DISPOSAL	POWER AVAILABLE
5A	PORTAL 63.9	YES	NO	NO
5A	PORTAL 67.4	YES	NO	NO
CORRIDOR 5A: SAN DIEGO RIVER TO SAN VICENTE RESERVOIR				
TUNNEL CORRIDOR IDENTIFICATION	DESCRIPTION AND MILEPOST	WATER AVAILABLE	ONSITE MUCK DISPOSAL	POWER AVAILABLE
5A	PORTAL 68.1	YES	NO	NO
5A	PORTAL 71.6	YES	NO	NO
ESP BEELER CANYON TUNNEL: SAN VICENTE RESERVOIR TO SECOND AQUEDUCT				
TUNNEL CORRIDOR IDENTIFICATION	DESCRIPTION AND MILEPOST	WATER AVAILABLE	ONSITE MUCK DISPOSAL	POWER AVAILABLE
BEELER CANYON	PORTAL 0.0	YES	NO	YES
BEELER CANYON	SHAFT 1.3	NO	NO	NO
BEELER CANYON	SHAFT 3.5	NO	NO	NO
BEELER CANYON	SHAFT 7.3	YES	NO	YES
BEELER CANYON	PORTAL 10.5	YES	NO	YES

Table 11-15
Tunnel Cost Summary**

Corridor No.	Contract No.	Portal Cost ($)	Shaft Depth (ft)	Shaft Cost ($/ft)	Total Shaft Cost ($)	Tunnel Length (ft)	Partial Lining Tunnel Cost ($/ft)	Partial Lining Total Tunnel Cost ($)	Full Lining Tunnel Cost ($/ft)	Full Lining Total Tunnel Cost ($)	Partial Lining Total Contract Cost* ($)	Full Lining Total Contract Cost ($)
3A	A	500,000				20,330	1,534	31,183,132	1,986	40,369,026	31,683,132	40,869,026
3A	B		2,868	14,965	42,918,738	38,940	2,821	109,862,837	2,983	116,165,249	152,781,575	159,083,987
3A	C		2,302	16,117	37,101,107	38,540	4,063	156,601,946	4,063	156,601,946	193,703,053	193,703,053
3A	D		2,594	15,460	40,102,429	39,995	2,891	115,617,297	3,327	133,059,334	155,719,726	173,161,763
3A	E		1,007	23,625	23,790,450	40,260	1,403	56,489,617	1,989	80,085,441	80,280,067	103,875,890
3A	F		375	12,232	4,586,938	20,195	1,628	32,876,859	2,017	40,737,774	37,463,796	45,324,712
3A	G	500,000				20,860	1,673	34,893,897	1,973	41,158,958	35,393,897	41,658,958
3A	H	1,000,000				11,300	1,715	19,375,962	2,167	24,489,033	20,375,962	25,489,033
										3A Total =	707,401,209	783,166,422
										3A $/ft =	3,070	3,399
3B	A	1,000,000				9,600	3,419	32,821,649	3,419	32,821,649	33,821,649	33,821,649
3B	B	500,000				22,600	1,377	31,121,293	1,944	43,945,150	31,621,293	44,445,150
3B	C		1,485	19,329	28,703,573	43,200	1,560	67,387,262	2,034	87,859,463	96,090,834	116,563,036
3B	D		1,315	20,499	26,956,228	41,700	1,607	66,999,877	2,119	88,356,726	93,956,105	115,312,954
3B	E	500,000				21,100	2,141	45,173,447	2,600	54,854,182	45,673,447	55,354,182
										3B Total =	301,163,328	365,496,971
										3B $/ft =	2,179	2,645
5A	A	500,000				18,750	1,449	27,172,968	1,970	36,940,788	27,672,968	37,440,788
5A	B		3,440	14,185	48,798,040	40,920	2,235	91,459,023	2,853	116,758,503	140,257,063	165,556,543
5A	C		3,030	14,714	44,583,855	39,595	2,079	82,323,759	2,684	106,288,516	126,907,614	150,872,371
5A	D		2,730	15,202	41,500,305	33,400	1,800	60,118,860	2,275	75,994,230	101,619,165	117,494,535
5A	E		1,750	17,959	31,427,375	31,025	1,931	59,912,146	2,359	73,183,545	91,339,521	104,610,920
5A	F	500,000				15,050	1,510	22,724,780	2,023	30,441,030	23,224,780	30,941,030
5A	G	1,000,000				18,200	1,548	28,178,621	1,975	35,949,589	29,178,621	36,949,589
5A	H	1,000,000				18,700	1,523	28,473,343	1,969	36,814,525	29,473,343	37,814,525
										5A Total =	569,673,075	681,680,301
										5A $/ft =	2,642	3,161
5C	A	1,000,000				18,200	1,548	28,178,621	1,975	35,949,589	29,178,621	36,949,589
5C	B	1,000,000				18,700	1,523	28,473,343	1,969	36,814,525	29,473,343	37,814,525
										5C Total =	58,651,964	74,764,114
										5C $/ft =	1,589	2,026

* Partial lining scenario used as basis for tunnel cost estimates.
** Detailed cost breakbowns and example computations are provided in Appendix A.

11.2.6 Electric Transmission Lines and Substations

Transmission Lines. The transmission lines supplying power to the pumping stations are assumed to have a voltage of 230 kV. The transmission lines carrying power away from the proposed power generating plants are assumed to have a voltage of 69 kV.

Estimated unit costs for the 230 kV transmission lines are provided in Table 11-16. Estimated unit costs for the 69 kV transmission lines are provided in Table 11-17. Estimated land acquisition costs are based on a right-of-way width of 100 feet for a 230 kV transmission line and 60 feet for a 69 kV transmission line.

Substation--230 kV. Information on the transmission system additions required to interconnect each of the alternatives was developed based on the results of the technical analyses and associated assumptions discussed in Section 7.0.

The above assumptions were utilized in conjunction with unit cost information (based on historical equipment and construction costs) to develop specific estimates of probable costs for the interconnection facilities required to serve each of the Project alternatives. The results are summarized in Table 11-18

Substations--69 kV. The cost estimates for substation additions are based on the addition of a 69 kV bay for each new line at existing substations as shown in Table 11-19. This is based on the need for extension of an existing 69 kV wide flange box structure, 69 kV circuit breaker, 69 kV disconnect switches (two each), one control panel, one protective relaying panel, addition of supervisory control equipment package, and miscellaneous materials such as rigid bus, bolted connectors, insulators, and erection materials. Also, the cost of installation labor is estimated on a per bay addition basis. This estimate is based on the assumption of a level site requiring no additional site preparation.

11.2.7 Water Treatment

Capital costs for water treatment and brine disposal facilities were estimated based on the water quality characteristics and concept designs discussed in Section 6.0. Treatment facility costs were estimated based on construction of reverse osmosis facilities at or near the existing Mirimar and Alvarado Water Treatment Plants, located on the west side of the water transfer system. Blended water quality would be 500 mg/l TDS. Brine disposal costs were estimated based on construction of new gravity sewers and a pump lift

Table 11-16
230 kV Transmission Line Unit
Cost Estimate*

Description	Material, $	Labor, $	Total, $
Structures	74,600	16,100	90,700
Conductor	42,900	34,700	77,600
Shield Wire	1,400	4,100	5,500
Foundations	--	40,100	40,100
Insulators, Hardware, and Grounding	17,800	8,500	26,300
Total Cost/Mile	136,700	103,500	240,200

*Land acquisition costs are accounted for separately in the cost summary table.

Table 11-17
69 kV Transmission Line Unit
Cost Estimate*

Description	Material, $	Labor, $	Total, $
Structures	27,200	6,800	34,000
Conductor	21,500	17,400	38,900
Shield Wire	1,400	4,100	5,500
Foundations	--	31,100	31,100
Insulators, Hardware, and Grounding	7,500	3,800	11,300
Total Cost/Mile	57,600	63,200	120,800

*Land acquisition costs are accounted for separately in the cost summary table.

Table 11-18
Estimated Costs for Transmission Interconnection Facilities

Corridor	Assumed Facilities	Estimated Load Range, MW	Estimated Average Cost,* 1996-$1,000
1A	70 MVAR of shunt capacitors at Colorado River Aqueduct pumping plants	100	2,100
3A	Transformers and circuit breakers at Imperial Valley Substation	115-195	13,000
3B	Transformers and circuit breakers at Imperial Valley Substation	195 260 325	15,000
5A	Transformers and circuit breakers at Imperial Valley	90 120 150	12,000
5C	Transformers and circuit breakers at Imperial Valley	220 295 370	15,000

*Excluding contingency and indirect costs.

Table 11-19
Substation Cost Estimate
69 kV Substation Bay Addition

Equipment	Units Required	Unit Cost ($)	Installation Labor ($)	Total Cost ($)
69 kV Circuit Breaker, SF6, 1,200A Cont. 31.5 kA Interrupt	1	40,000	960	40,960
69 kV Disc. Switch, 1,200A	2	6,000	2,000	16,000
Control Panel, Open Rack	2	1,800	640	4,880
Relaying Package (Installed)	1	18,000		18,000
SCADA Package	1	14,000	640	14,640
Rigid Bus, 3 in. and Fittings	80 ft	25/ft	32/ft	4,560
Insulators	12	140	120/in	3,120
Wide Flange Steel Bay	1	8,000	3,200	11,200
Foundations, Pier	2	500	560/pier	2,120
Foundation, Circuit Breaker	1	1,000	1,440	2,440
Total Cost				117,920

station to convey the brine discharge from the treatment facilities to the South Bay Outfall. Water treatment costs for Corridors 3A, 3B, 5A, and 5C are based on an estimated unit construction cost of $759/AF of delivered water. Accounting for brine disposal requirements, the estimated annual deliverable water volume will as follows for the transfer volumes considered:

Transfer Volume (acre-feet)	Brine Disposal Volume (acre-feet)	Deliverable Volume (acre-feet)
300,000	39,900	260,100
400,000	53,200	346,800
500,000	66,500	433,500

11.2.8 Environmental Permitting and Mitigation

11.2.8.1 Environmental Permitting. The environmental permitting cost estimates are general and were developed by identifying the major environmental permits and approvals required for each corridor, and then estimating the costs of acquiring the necessary permits. The cost estimates include work required by the Authority, Authority consultants and regulatory agencies, and also include actual estimated permit fees, if applicable. The costs also include the work needed to complete the required technical analyses for permit applications, prepare the permit applications and negotiate permitting and mitigation requirements with the involved regulatory agencies. The estimated environmental permitting costs are presented in Table 11-20 for Corridors 3A, 3B, 5A, and 5C extending from Drop No. 1 on the AAC to the Second Aqueduct.

The environmental permitting cost estimates were developed on the basis of Woodward-Clyde Consultants' experience in permitting of other similar projects, including pipelines of various types and other types of facilities, in California and other states.

11.2.8.2 Environmental Mitigation. The environmental mitigation cost estimates are general and were developed by considering the environmental impacts of implementing the project within each corridor and the environmental permitting requirements for the project. The cost estimates include costs for work needed by the Authority or its consultants to complete the required mitigation, direct habitat compensation (acquisition) costs, and other types of direct costs (e.g., for revegetation of the construction right-of-way). The estimated environmental mitigation costs are presented in Table 11-21 for Corridors 3A, 3B, 5A, and 5C extending from Drop No. 1 on the AAC to the Second Aqueduct.

Table 11-20
Estimated Environmental Permitting Costs
(Drop No. 1 to Second Aqueduct)

Regulatory Agency	Potentially Required Permit or Approval	Estimated Permitting Cost ($) for Each Corridor			
		3A	3B	5A	5C
Federal					
USDI Bureau of Land Management (BLM)	Grant of Right-of-Way	10,000	10,000	10,000	10,000
	NEPA Compliance (EIS)	1,500,000	1,500,000	1,200,000	1,500,000
	Temporary Use Permit	3,000	3,000	3,000	3,000
	Issuance of Noncompetitive Sales of Mineral Material Contracts (pipeline bedding material)	1,000	1,000	1,000	1,000
	Assurance of Compliance with Certain Applicable Federal Laws, Orders, and Regulations, including:				
	Endangered Species Act of 1973 (as amended)[a]	---	---	---	---
	Executive Order 11593 (Protection and Enhancement[b] of the Cultural Environment) and the Historic Preservation Act of 1966 (as amended), Section 106	---	---	---	---
	Executive Order 11988, Floodplain Management[c]	---	---	---	---
US Forest Service	Special Use Permit	5,000	5,000	5,000	5,000
	NEPA Compliance (EIS)[c]	---	---	---	---
US Fish and Wildlife Service (USFWS)	Endangered Species Act Compliance (includes endangered species surveys, biological assessment, mitigation agreement)	400,000	400,000	320,000	400,000
	Fish and Wildlife Coordination Act (FWCA)[c]	---	---	---	---
US DOI, Advisory Council on Historic Preservation	National Historic Preservation Act (NHPA), Section 106 Compliance (including site testing, excluding mitigation)	400,000	400,000	320,000	400,000
US DOD, Army Corps of Engineers (ACOE)	Section 404 Permits (Stream and River Crossings)	150,000	150,000	120,000	150,000

Table 11-20 (Continued)
Estimated Environmental Permitting Costs
(Drop No. 1 to Second Aqueduct)

Regulatory Agency	Potentially Required Permit or Approval	Estimated Permitting Cost ($) for Each Corridor			
		3A	3B	5A	5C
California					
Department of Parks and Recreation	Special Use Permit	5,000	5,000	5,000	---
Department of Fish and Game (CDFG)	Compliance with CA Endangered Species Act[a]	---	---	---	---
	Stream Alteration Agreement[d]	---	---	---	---
Department of Transportation (CalTrans)	Encroachment Permits (crossings of state highways)	30,000	30,000	25,000	30,000
State Water Resources Control Board, Regional Board (CSWRCB)	NPDES Permit/Report of Waste Discharge (hydrostatic test water discharges and tunnel dewatering)	50,000	50,000	50,000	50,000
CSWRCB, Division of Water Rights	Temporary Permit to Appropriate Water (hydrostatic test water)	10,000	10,000	10,000	10,000
Local					
SDCWA	CEQA compliance[c]	---	---	---	---
Other	Combined local permitting (encroachment, grading, road crossings, zoning)	100,000	100,000	80,000	100,000
Total		2,664,000	2,664,000	2,149,000	2,659,000

[a]Included in USFWS Endangered Species Act compliance costs.

[b]Included in NHPA, Section 106 compliance costs.

[c]Included in NEPA compliance costs.

[d]Included in ACOE Section 404/10 costs.

Table 11-21
Estimated Environmental Mitigation Costs
(Drop No. 1 to Second Aqueduct)

Mitigation Category	Estimated Mitigation Cost ($) for Each Alternative			
	3A	3B	5A	5C
Biological Resources				
Endangered Species and Wetlands				
Habitat Compensation and Restoration (Vegetation/Wildlife/Wetlands)	1,300,000	1,400,000	900,000	900,000
Preconstruction, Construction, and Post-Construction Monitoring (Vegetation/Wildlife)	2,100,000	2,300,000	1,600,000	3,000,000
Cultural Resources				
Construction (Emergency Discovery) Monitoring	2,100,000	2,300,000	1,600,000	3,000,000
Site Excavation and Data Recovery	1,000,000	1,000,000	500,000	1,500,000
Revegetation	800,000	1,000,000	750,000	2,300,000
Other Mitigation (Visual Resources, Socioeconomics, Land Use, Other)	400,000	400,000	300,000	400,000
Total	7,700,000	8,400,000	5,650,000	11,100,000

The environmental mitigation cost estimates were developed on the basis of Woodward-Clyde Consultants' experience in permitting and mitigation of other similar projects, including pipelines of various types and other types of facilities, in California and other states.

The environmental mitigation costs do not include mitigation of impacts related to various Imperial Valley issues, primarily including effects of reduced irrigation return water flows to the Salton Sea, potential changes in the area and types of agricultural land in production or any other similar issues.

The biological and cultural resources survey, permitting, and mitigation costs are based on the number of miles of canal and pipeline conveyance, and the number of miles of tunnel conveyance. They also consider the numbers, types, and locations of resources that might be affected by surface construction.

11.2.9 Other Corridor Costs

Storage Reservoirs. A storage reservoir will be required for each corridor to provide daily operational storage, to balance variations in monthly supply and demand, and to provide storage for periods of scheduled and unscheduled pumping outages. The costs for storage reservoirs are accounted for in the Emergency Storage Project cost estimates ("Emergency Storage Project-Draft Opinion of Probable Phase II System Costs," GEI Consultants, Inc., February 8, 1995), and are therefore not included in the corridor cost estimates presented in this study.

Corridors 1A and 3A would utilize the proposed Moosa Reservoir for storage. Corridors 3B, 5A, and 5C would utilize an expansion of San Vicente Reservoir. The ESP cost estimate indicates a cost of $294,400,000 for Moosa Reservoir based on an active storage capacity of 68,000 acre-feet. This active capacity approximately corresponds to the required 67,000 acre-feet active capacity identified in Section 7.4 of this study. The ESP cost estimate indicates a cost of $131,200,000 to expand San Vicente Reservoir by 68,000 acre-feet. These costs are in late 1994 dollars and include contingency, engineering, and administration allowances, and cost offsets.

Beeler Canyon System. Corridors 3B, 5A, and 5C utilize the Beeler Canyon System from San Vicente Reservoir to the Second Aqueduct. The Beeler Canyon System, as developed for the Emergency Storage Project evaluations, originates on the west side of San Vicente Reservoir and terminates at the Second Aqueduct near Mercy Road. A pumping plant near San Vicente Reservoir would be provided to lift the design flows to a sufficient elevation to match operating heads at the Second Aqueduct. The costs for these

facilities are included in the ESP cost estimates and are therefore not included in the corridor cost estimates presented in this study.

The ESP cost estimate indicates a cost of $135,600,000 for the Beeler Canyon System and a cost of $46,800,000 for the San Vicente Pumping Station. These costs are in late 1994 dollars and include contingency, engineering, and administration allowances, and cost offsets.

Canal Extension from Drop No. 1 to Colorado River. The opinions of probable cost presented in this study are based on Corridors 3A, 3B, 5A, and 5C extending from Drop No. 1 on the All-American Canal to the Second Aqueduct. However, total capital costs were also estimated for extending the corridors from Drop No. 1 to the Colorado River as follows:

	Annual Transfer Volume		
Item	300,000 AF	400,000 AF	500,000 AF
	($)	($)	($)
Canals*	27,119,000	29,038,000	30,814,000
Land Acquisition	6,550,000	6,550,000	6,550,000
Environmental Permitting and Mitigation	2,000,000	2,000,000	2,000,000
Subtotal	35,669,000	37,588,000	39,364,000
Contingency at 25 percent	8,917,000	9,397,000	9,841,000
Subtotal	44,586,000	46,985,000	49,205,000
Indirects at 15 percent	6,688,000	7,048,000	7,381,000
Total Estimated Capital Cost	51,274,000	54,033,000	56,586,000

*Includes estimated costs for concrete lined canals, siphons, drainage undercrossings and overchutes, and a turnout structure.

11.3 Annual Costs

Annual costs for the water transfer system include pumping energy costs, operating, maintenance, and replacement (OM&R) costs, and annual water treatment costs. For Corridors 3B and 5C, annual costs savings would result from installation of power generating facilities to recover available energy within the system. This section describes the basis for the estimates of annual cost.

11.3.1 Pumping Energy Costs

Pumping energy costs were estimated for each corridor and transfer volume based on the following:

- Total dynamic pumping head for each corridor as indicated in Section 2.0.

- System design hydraulic capacity for each transfer volume as indicated in Section 7.0.
- Annual pumping duration of 7,963 hours as indicated in Section 5.0.

An overall plant efficiency of 80 percent was used for the annual energy estimates. Estimated annual pumping energy requirements for each corridor and transfer volume are indicated in Table 11-22. Estimated annual pumping costs in 1996 dollars were determined based on an average energy cost of $30.00/MWh.

Table 11-22
Estimated Annual Pumping Energy (MWh)

Corridor	Total Pumping Head (ft)	Annual Transfer Volume (acre-feet)		
		300,000	400,000	500,000
1A	1,662	638,200	--	--
3A	2,000	767,000	1,024,000	1,280,000
3B--w/o Beeler System	3,600	1,382,400	1,813,100	2,303,900
3B--Beeler System	580	222,700	297,000	371,200
3B--Total	4,180	1,605,100	2,140,100	2,675,100
5A--w/o Beeler System	1,600	614,400	819,100	1,024,000
5A--Beeler System	580	222,700	297,000	371,200
5A--Total	2,180	837,100	1,116,100	1,395,200
5C--w/o Beeler System	4,000	1,536,000	2,047,900	2,559,900
5C--Beeler System	580	222,700	297,000	371,200
5C--Total	4,580	1,758,700	2,344,900	2,931,100

11.3.2 Energy Recovery Value

The value of recovered energy was estimated for Corridors 3B and 5A for each transfer volume based on the following:

- Total available net head for each corridor as indicated in Section 2.0.
- System design hydraulic capacity for each transfer volume as indicated in Section 7.0.
- Annual generating period of 7,963 hours, corresponding to the annual pumping duration.

An overall plant efficiency of 85 percent was used for the annual energy estimates. Estimated annual recovered energy for Corridors 3B and 5C is indicated in Table 11-23. Recovered energy was considered to offset a portion of the transfer system pumping

power requirements. The value of recovered energy in 1996 dollars was determined based on an average energy value of $30.00/MWh.

Table 11-23
Estimated Annual Energy Recovery (MWh)

Corridor	Total System Net Head (ft)	Annual Transfer Volume (acre-feet) 300,000	400,000	500,000
3B	2,100	548,300	731,100	913,900
5C	2,350	613,600	818,200	1,022,700

11.3.3 Operation and Maintenance Costs

Power Generating/Pressure Control Facilities and Pumping Plants. Operation and maintenance (O&M) costs represent the average annual costs of maintaining a facility at full operating efficiency throughout its useful life. This cost includes the salaries of operating personnel; the cost of labor, plant, and supplies for ordinary maintenance and repairs; and applicable supervisory and overhead costs. O&M costs are a function of numerous variables, including project total installed capacity and type of operation, head, water quality, project location, labor and material costs, and others.

For purposes of these evaluations, O&M costs for the power generating/pressure control facilities and the pumping plants were based on a study by the Corps of Engineers of maintenance and cost information for numerous hydroelectric facilities.* The results of the study allow for estimation of O&M costs based on installed capacity. The study results were also used for pumping plants using the installed pumping power requirement.

The following O&M costs were selected for use and are based on installed capacity associated with the 400,000 AF/y transfer volume. O&M costs developed for this transfer volume were also used for the 300,000 and 500,000 AF/y transfer volumes:

Item	Annual O&M Cost (1996$)
Power Generating/Pressure Control Facilities	
Surface Facility (First Facility)	300,000
Surface Facility (Each Additional Facility)	200,000
Underground Facility (Corridor 3B)	410,000

*"Predicting O&M Costs Prior to Design," B. Clowes and J. McHan, COE-Portland, as published in Hydro Review, February 1987.

Pumping Plants	
First Plant	360,000
Each Additional Plant	250,000

Pipelines. Estimated O&M costs for the pipelines and tunnels are $400,000 annually based on a five person (average) maintenance crew, including equipment.

11.3.4 Replacement Costs

Equipment replacement costs are applicable to the power generating/pressure control facilities and pumping plants. Major powerhouse/pumping plant and equipment components may require replacement before the end of the projected project life. Examples are generator windings, turbine runners and pump impellers, thrust bearings, pumps, air compressors, communications equipment, generator, voltage regulation and excitation equipment, and certain types of transformers. The replacement cost for a facility is the estimated future cost of such replacements, converted to an equivalent average annual value over the entire project life.

Annual replacement costs were estimated at approximately 0.2 percent of the powerhouse or pumping plant costs. The following annual replacement costs were selected:

Item	Estimated Annual Replacement Cost (1996$)
Power Generating/Pressure Control Facilities	
Surface Facility	75,000
Underground Facility (Corridor 3B)	150,000
Pumping Plants	80,000

11.3.5 Water Treatment Costs

Annual costs for water treatment and brine disposal were estimated based on the water quality characteristics and concept designs discussed in Section 6.0. Annual costs include operation and maintenance costs associated with the reverse osmosis and brine disposal facilities. Treatment facilities would be located on the west side of the transfer system. Blended water quality would be 500 mg/l TDS. For Corridor 1A, estimated unit annual costs are $48.70 per acre-foot of delivered water. For Corridors 3A, 3B, 5A, and 5C, estimated annual costs are $69.50 per acre-foot of delivered water.

11.4 Summary of Estimated Costs

The following tables provide cost breakdowns by major component for each corridor and transfer volume.

Tables 11-24 through 11-29	Corridor Cost Summary Tables
Tables 11-30 through 11-37	Cost Summary Tables--300,000 AF Transfer Volume
Tables 11-38 through 11-45	Cost Summary Tables--400,000 AF Transfer Volume
Tables 11-46 through 11-53	Cost Summary Tables--500,000 AF Transfer Volume

Corridor Cost Summary Tables

TABLE 11-24 COST SUMMARY - CORRIDOR 1A - CRA EXPANSION (Stage 1)

ANNUAL TRANSFER VOLUME = 200,000 AF

ESTIMATED CAPITAL COSTS*				
ITEM	UNIT COST	UNIT	QUANTITY	COST* ($1,000)
Raise Casa Loma Siphon	1,065	LF	15,312	16,307
Replace Cut-and-Cover Conduit	222,500,000	LS	1	222,500
Raise 20' Canals	41,700,000	LS	1	41,700
Rebuild Siphon Transitions	260,000	EA	217	56,420
Add 3rd Barrel to Siphons	1,095	LF	80,300	87,929
Rebuild Siphons-Type 11	2,900	LF	1,320	3,828
Rebuild Siphons-Type 12	2,010	LF	7,810	15,698
Electric Transmission Interconnection	2,100,000	LS	1	2,100
Land Acquisition (Stage 1 and 2)	10,000	AC	6,000	60,000
SUBTOTAL				**506,482**
Contingency @ 35%				177,269
SUBTOTAL				**683,751**
Indirect Costs @ 15%				102,563
Water Treatment**	570	AF	181,400	103,398
TOTAL ESTIMATED CAPITAL COSTS				**889,711**

ESTIMATED ANNUAL COSTS*	
ITEM	COST* ($1,000)
Pumping Energy	12,764
O & M and Replacement	390
Water Treatment	8,834
Energy Recovery	0
TOTAL ESTIMATED ANNUAL COSTS	21,988

Note: As discussed in Section 11.1.1, total estimated capital costs indicated above represent a "best case" scenario. The likely upper limit of Stage 1 development costs is approximately $1,430,000,000 corresponding to an addition of approximately $540 million to the best case costs.

* Costs are in January 1996 $1,000

** Includes contingency and indirect cost allowances. Based on delivered water volume.

TABLE 11-25 COST SUMMARY - CORRIDOR 1A - NEW SYSTEM (Stage 2)

ANNUAL TRANSFER VOLUME = 300,000 AF

ESTIMATED CAPITAL COSTS*				
ITEM	UNIT COST	UNIT	QUANTITY	COST* ($1,000)
Tunnels	2,000	LF	472,630	945,260
San Diego and Casa Loma Canals	140	LF	97,152	13,601
CRA Canals	170	LF	332,650	56,551
Gravity RCP	1,425	LF	252,340	359,585
Siphon Transitions	160,000	EA	217	34,720
Siphon RCP	1,400	LF	104,742	146,639
Pumping Plants	80,000,000	LS	1	80,000
Electric Transmission Lines	240,200	MI	125	30,025
SUBTOTAL				**1,666,381**
Contingency @ 35%				583,233
SUBTOTAL				**2,249,614**
Indirect Costs @ 15%				337,442
Water Treatment**	570	AF	272,100	155,097
TOTAL ESTIMATED CAPITAL COSTS				**2,742,154**

ESTIMATED ANNUAL COSTS*	
ITEM	COST* ($1,000)
Pumping Energy	19,146
O & M and Replacement	2,700
Water Treatment	13,251
Energy Recovery	0
TOTAL ESTIMATED ANNUAL COSTS	**35,097**

* Costs are in January 1996 $1,000

** Includes contingency and indirect cost allowances. Based on delivered water volume.

TABLE 11-26 COST SUMMARY - CORRIDOR 3A

ESTIMATED CAPITAL COSTS*			
	ANNUAL TRANSFER VOLUME		
ITEM	300,000 AF ($1,000)	400,000 AF ($1,000)	500,000 AF ($1,000)
Canals	82,084	87,576	90,480
Pipelines	247,609	289,392	349,044
Tunnels	1,063,784	1,063,784	1,063,784
Pumping Plants	91,873	111,556	124,038
Power Generating / Pressure Control Facilities	0	0	0
Electric Transmission Lines	52,920	52,920	52,920
Environmental Permitting and Mitigation	12,955	12,955	12,955
SUBTOTAL	**1,551,225**	**1,618,183**	**1,693,221**
Indirect Costs @ 15%	232,684	242,727	253,983
Water Treatment**	197,400	263,200	329,000
TOTAL ESTIMATED CAPITAL COSTS	**1,981,309**	**2,124,110**	**2,276,204**

ESTIMATED ANNUAL COSTS*			
ITEM	($1,000)	($1,000)	($1,000)
Pumping Energy	23,010	30,720	38,400
O & M and Replacement	1,875	1,875	1,875
Water Treatment	18,100	24,100	30,100
Energy Recovery	0	0	0
TOTAL ESTIMATED ANNUAL COSTS	**42,985**	**56,695**	**70,375**

* Costs are in January 1996 $1,000

** Includes indirect cost allowance.

TABLE 11-27 COST SUMMARY - CORRIDOR 3B

ESTIMATED CAPITAL COSTS*			
	ANNUAL TRANSFER VOLUME		
ITEM	300,000 AF ($1,000)	400,000 AF ($1,000)	500,000 AF ($1,000)
Canals	82,084	87,576	90,480
Pipelines	285,093	335,056	394,261
Tunnels	453,307	453,307	453,307
Pumping Plants	156,671	190,344	216,863
Power Generating / Pressure Control Facilities	91,034	114,827	140,718
Electric Transmission Lines	68,725	68,725	68,725
Environmental Permitting and Mitigation	13,830	13,830	13,830
SUBTOTAL	**1,150,744**	**1,263,665**	**1,378,184**
Indirect Costs @ 15%	172,612	189,550	206,728
Water Treatment**	197,400	263,200	329,000
TOTAL ESTIMATED CAPITAL COSTS	**1,520,756**	**1,716,415**	**1,913,912**

ESTIMATED ANNUAL COSTS*			
ITEM	($1,000)	($1,000)	($1,000)
Pumping Energy***	48,153	64,203	80,253
O & M and Replacement	4,282	4,282	4,282
Water Treatment	18,100	24,100	30,100
Energy Recovery	(16,449)	(21,933)	(27,417)
TOTAL ESTIMATED ANNUAL COSTS	**54,086**	**70,652**	**87,218**

* Costs are in January 1996 $1,000

** Includes indirect cost allowance.

*** Includes pumping energy for Beeler Canyon System.

TABLE 11-28 COST SUMMARY - CORRIDOR 5A

ESTIMATED CAPITAL COSTS*			
	ANNUAL TRANSFER VOLUME		
ITEM	300,000 AF ($1,000)	400,000 AF ($1,000)	500,000 AF ($1,000)
Canals	54,938	58,985	61,275
Pipelines	194,858	227,199	265,129
Tunnels	857,081	857,081	857,081
Pumping Plants	64,799	78,788	92,825
Power Generating / Pressure Control Facilities	0	0	0
Electric Transmission Lines	33,410	33,410	33,410
Environmental Permitting and Mitigation	9,749	9,749	9,749
SUBTOTAL	**1,214,835**	**1,265,212**	**1,319,469**
Indirect Costs @ 15%	182,225	189,782	197,920
Water Treatment**	197,400	263,200	329,000
TOTAL ESTIMATED CAPITAL COSTS	**1,594,460**	**1,718,194**	**1,846,389**

ESTIMATED ANNUAL COSTS*			
ITEM	($1,000)	($1,000)	($1,000)
Pumping Energy***	25,113	33,483	41,856
O & M and Replacement	1,875	1,875	1,875
Water Treatment	18,100	24,100	30,100
Energy Recovery	0	0	0
TOTAL ESTIMATED ANNUAL COSTS	**45,088**	**59,458**	**73,831**

* Costs are in January 1996 $1,000

** Includes indirect cost allowance.

*** Includes pumping energy for Beeler Canyon System.

TABLE 11-29 COST SUMMARY - CORRIDOR 5C

ESTIMATED CAPITAL COSTS*			
	ANNUAL TRANSFER VOLUME		
ITEM	300,000 AF ($1,000)	400,000 AF ($1,000)	500,000 AF ($1,000)
Canals	45,820	49,284	51,279
Pipelines	554,541	625,198	748,120
Tunnels	88,451	88,451	88,451
Pumping Plants	161,996	196,969	232,063
Power Generating / Pressure Control Facilities	94,603	106,731	124,779
Electric Transmission Lines	49,085	49,085	49,085
Environmental Permitting and Mitigation	17,199	17,199	17,199
SUBTOTAL	**1,011,695**	**1,132,917**	**1,310,976**
Indirect Costs @ 15%	151,754	169,938	196,646
Water Treatment**	197,400	263,200	329,000
TOTAL ESTIMATED CAPITAL COSTS	**1,360,849**	**1,566,055**	**1,836,622**

ESTIMATED ANNUAL COSTS*			
ITEM	($1,000)	($1,000)	($1,000)
Pumping Energy	52,761	70,347	87,933
O & M and Replacement	4,271	4,271	4,271
Water Treatment	18,100	24,100	30,100
Energy Recovery	(18,408)	(24,546)	(30,681)
TOTAL ESTIMATED ANNUAL COSTS	**56,724**	**74,172**	**91,623**

* Costs are in January 1996 $1,000

** Includes indirect cost allowance.

*** Includes pumping energy for Beeler Canyon System.

Cost Summary Tables--300,000 AF Transfer

TABLE 11 - 30. COST SUMMARY - 300,000 AF; CANALS

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	82,084
3B	82,084
5A	54,938
5C	45,820

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
Turnout	1,086,000	LS	1	1,086	1	1,086	1	1,086	1	1,086
Concrete Lined Canal	61	LF	489,000	29,829	489,000	29,829	296,500	18,087	234,000	14,274
Inverted Siphon	Varies	LS	1	16,531	1	16,531	1	14,132	1	12,900
Under Crossing	Varies	LS	1	1,221	1	1,221	1	396	1	396
Land Acquisition	10,000	AC	1,700	17,000	1,700	17,000	1,025	10,250	800	8,000
SUBTOTAL				**66,667**		**66,667**		**43,951**		**36,656**
Contingency	25	%		16,417		16,417		10,988		9,164
TOTAL CAPITAL COST				**82,084**		**82,084**		**54,938**		**45,820**

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** Included with Pipeline Operation and Maintenance Costs

TABLE 11 - 31. COST SUMMARY - 300,000 AF; PIPELINES

SUMMARY OF COSTS*		
CORRIDOR	CAPITAL	O&M
3A	247,609	500
3B	285,093	500
5A	194,658	500
5C	554,541	500

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
96" -Dia. Pipe (33ksi)										
0.5" (1/2") Wall Pipe	300	LF	23,180	6,954	99,800	29,940	94,500	28,350	213,320	63,996
0.625" (5/8") Wall Pipe	390	LF	19,800	7,644	33,300	12,987	23,800	9,282	102,440	39,952
0.750" (3/4") Wall Pipe	470	LF	67,600	31,772	31,200	14,664	19,500	9,165	53,300	25,051
0.875" (7/8") Wall Pipe	580	LF	43,800	25,404	44,800	25,984	28,500	16,530	69,700	40,426
1.0" (1") Wall Pipe	900	LF	22,700	20,430	18,000	16,200		0	20,600	18,540
Installation/Welding/Joints	135	LF	176,880	23,879	227,100	30,659	166,300	22,451	459,360	62,014
Trenching										
Open - Cut Excavation	112	LF	106,840	11,966	105,210	11,784	61,866	6,931	265,800	29,770
Open - Cut Backfill	193	LF	106,840	19,552	105,210	19,253	61,866	11,325	265,800	48,641
Shored Excavation	180	LF	70,050	12,609	116,550	20,979	92,280	16,612	169,800	30,564
Shored Backfill	123	LF	70,050	8,616	116,550	14,336	92,280	11,352	169,800	20,885
Accessories/Specials										
Appurtenances	31	LF	176,880	5,413	227,100	6,949	166,300	5,089	459,360	14,056
Fault Crossing	20,000	EA		0		0		0		0
Highway Crossings	1,600	LF	150	240	300	480	150	240	4,250	6,800
Railroad Crossings	1,600	LF		0		0		0	450	720
River Crossings	1,700	LF	5,450	9,265	2,650	4,505	2,350	3,995	2,500	4,250
Surface/Utilities	50	LF	176,880	8,844	227,100	11,355	166,300	8,315	459,360	22,968
Land Acquisition	10,000	AC	550	5,500	700	7,000	525	5,250	1,400	14,000
San Vincente Outfall Structure	1,000,000	LS		0	1	1,000	1	1,000	1	1,000
SUBTOTAL				**198,087**		**228,074**		**155,887**		**443,633**
Contingency	25	%		49,522		57,019		38,972		110,908
TOTAL CAPITAL COST				**247,609**		**285,093**		**194,658**		**554,541**

OPERATION AND MAINTENANCE COSTS										
Operation and Maintenance	400,000	LS	1	400	1	400	1	400	1	400
Contingency	25	%		100		100		100		100
TOTAL O&M COST				**500**		**500**		**500**		**500**

* Costs are in January 1998 $1,000

TABLE 11 - 32. COST SUMMARY - 300,000 AF; TUNNELS

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	1,063,784
3B	453,307
5A	857,081
5C	88,451

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
Corridor 3A	3,070	LF	230,420	707,389		0		0		0
Corridor 3B	2,179	LF		0	138,200	301,138		0		0
Corridor 5A	2,642	LF		0		0	215,640	569,721		0
Corridor 5C	1,589	LF		0		0		0	36,900	58,634
Land Acquisition	10,000	AC	270	2,700	160	1,600	250	2,500	50	500
Contingency	50	%		353,695		150,569		284,860		29,317
TOTAL CAPITAL COST				1,063,784		453,307		857,081		88,451

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** Included with Pipeline Operation and Maintenance Costs

TABLE 11 - 33. COST SUMMARY - 300,000 AF; PUMPING PLANTS

SUMMARY OF COSTS*		
CORRIDOR	CAPITAL	O&M
3A	91,873	1,375
3B	156,671	2,813
5A	64,799	1,375
5C	161,998	2,813

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
800' TDH Plant										
Civil-Structural										
Earth Excavation	3.00	CY	9,600	29	9,600	29	9,600	29	9,600	29
Rock Excavation	20.00	CY	13,600	272	13,600	272	13,600	272	13,600	272
Compacted Backfill	8.00	CY	23,200	186	23,200	186	23,200	186	23,200	186
Reinforced Concrete	350	CY	16,000	5,600	16,000	5,600	16,000	5,600	16,000	5,600
Superstructure	75.00	SF	10,400	780	10,400	780	10,400	780	10,400	780
Miscellaneous Metals	2,600	TN	65	169	65	169	65	169	65	169
Steel Piping / Bifurcation	1,300	LF	530	689	530	689	530	689	530	689
Cranes	360,000	LS	1	360	1	360	1	360	1	360
Elevator	150,000	LS	1	150	1	150	1	150	1	150
Architectural	75,000	LS	1	75	1	75	1	75	1	75
Sitework	100,000	LS	1	100	1	100	1	100	1	100
Access Road	450,000	MI	5	2,250	5	2,250	5	2,250	5	2,250
Mechanical										
Pumps	900,000	EA	4	3,600	4	3,600	4	3,600	4	3,600
Discharge Valves	130,000	EA	4	520	4	520	4	520	4	520
BOP Mechanical Systems	360,000	LS	1	360	1	360	1	360	1	360
Electrical										
Motors	1,400,000	EA	4	5,600	4	5,000	4	5,600	4	5,000
BOP Electrical Systems	880,000	LS	1	880	1	880	1	880	1	880
Plant Substation	2,700,000	LS	1	2,700	1	2,700	1	2,700	1	2,700
Forebay										
Earth Excavation	3.00	CY	60,000	180	60,000	180	60,000	180	60,000	180
Compacted Backfill	8.00	CY	60,000	480	60,000	480	60,000	480	60,000	480
Asphaltic Concrete Liner	18.00	SY	25,000	450	25,000	450	25,000	450	25,000	450
Outfall Structure	85,000	LS	1	85	1	85	1	85	1	85
Spillway Structure & Pipeline	150,000	LS	1	150	1	150	1	150	1	150
Sitework	55,000	LS	1	55	1	55	1	55	1	55
Land Acquisition	10,000	AC	10	100	10	100	10	100	10	100
SUBTOTAL				25,919		25,919		25,919		25,919
No. Required			2		4		2		5	
800' FACILITY TOTAL				51,838		103,678		51,838		129,597

* Costs are in January 1998 $1,000

TABLE 11 - 33. COST SUMMARY - 300,000 AF; PUMPING PLANTS (Continued)

CAPITAL COSTS*										
			CORRIDORS							
	UNIT		3A		3B		5A		5C	
ITEM	COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
400' TDH Plant										
Civil-Structural										
Earth Excavation	3.00	CY	9,600	28	9,600	29				
Rock Excavation	20.00	CY	13,600	272	13,600	272				
Compacted Backfill	8.00	CY	23,200	186	23,200	186				
Reinforced Concrete	350	CY	16,000	5,600	16,000	5,600				
Superstructure	75.00	SF	10,400	780	10,400	780				
Miscellaneous Metals	2,600	TN	65	169	65	169				
Steel Piping / Bifurcation	1,300	LF	530	689	530	689				
Cranes	360,000	LS	1	360	1	360				
Elevator	150,000	LS	1	150	1	150				
Architectural	75,000	LS	1	75	1	75				
Sitework	100,000	LS	1	100	1	100				
Access Road	450,000	MI	5	2,250	5	2,250				
Mechanical										
Pumps	600,000	EA	4	2,400	4	2,400				
Discharge Valves	90,000	EA	4	360	4	360				
BOP Mechanical Systems	320,000	LS	1	320	1	320				
Electrical										
Motors	970,000	EA	4	3,880	4	3,880				
BOP Electrical Systems	890,000	LS	1	890	1	890				
Plant Substation	1,850,000	LS	1	1,850	1	1,850				
Forebay										
Earth Excavation	3.00	CY	60,000	180	60,000	180				
Compacted Backfill	8.00	CY	60,000	480	60,000	480				
Asphaltic Concrete Liner	18.00	SY	25,000	450	25,000	450				
Outfall Structure	85,000	LS	1	85	1	85				
Spillway Structure & Pipeline	150,000	LS	1	150	1	150				
Sitework	55,000	LS	1	55	1	55				
Land Acquisition	10,000	AC	10	100	10	100				
400' FACILITY TOTAL			1	21,659	1	21,659		0		0
800' FACILITY TOTAL				51,839		103,678		51,839		128,597
PUMPING PLANT SUBTOTAL				73,498		125,337		51,839		128,597
Contingency	25	%		18,375		31,334		12,960		32,399
TOTAL CAPITAL COST				91,873		156,671		64,799		161,996

OPERATION AND MAINTENANCE COSTS										
O&M and Replacement	Varies	LS	1	1,100	1	2,090	1	1,100	1	2,090
Contingency	25	%		275		523		275		523
TOTAL O&M COST				1,375		2,613		1,375		2,613

* Costs are in January 1998 $1,000

TABLE 11 - 34. COST SUMMARY - 300,000 AF; POWER GENERATING / PRESSURE CONTROL FACILITIES

SUMMARY OF COSTS*		
CORRIDOR	CAPITAL	O&M
3A	0	0
3B	91,034	1,169
5A	0	0
5C	94,603	1,168

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
800' Net Head Plant										
Powerhouse										
Civil-Structural										
Earth Excavation	3.00	CY			7,000	21			7,000	21
Rock Excavation	20.00	CY			8,000	160			8,000	160
Compacted Backfill	8.00	CY			15,000	120			15,000	120
Reinforced Concrete	350	CY			16,400	5,380			16,400	5,380
Superstructure	75.00	SF			15,500	1,163			15,500	1,163
Miscellaneous Metals	2,600	TN			40	104			40	104
Steel Piping / Bifurcation	1,800	LF			370	666			370	666
Cranes	250,000	LS			1	250			1	250
Architectural	75,000	LS			1	75			1	75
Sitework	100,000	LS			1	100			1	100
Access Road	450,000	MI			5	2,250			5	2,250
Mechanical										
Turbine	3,850,000	LS			1	3,850			1	3,850
Inlet Valves	460,000	EA			4	1,840			4	1,840
Sleeve Valves	530,000	EA			3	1,590			3	1,590
BOP Mechanical Systems	450,000	LS			1	450			1	450
Electrical										
Generator	3,700,000	LS			1	3,700			1	3,700
BOP Electrical Systems	670,000	LS			1	670			1	670
Plant Substation	780,000	LS			1	780			1	780
Forebay										
Earth Excavation	3.00	CY			60,000	180			60,000	180
Compacted Backfill	8.00	CY			60,000	480			60,000	480
Asphaltic Conc. Liner	18.00	SY			28,000	504			28,000	504
Intake Structure	600,000	LS			1	600			1	600
Spillway Structure & Pipeline	150,000	LS			1	150			1	150
Sitework	55,000	LS			1	55			1	55
Land Acquisition	10,000	AC			10	100			10	100
SUBTOTAL						25,228				25,228
No. Required					1				3	
800' FACILITY TOTAL						25,228				75,683
1450' Underground PH	47,600,000	LS			1	47,600				
SUBTOTAL						72,828				75,683
Contingency	25	%				18,207				18,921
TOTAL CAPITAL COST						91,034				94,603

OPERATION AND MAINTENANCE COSTS										
O&M and Replacement	Varies	LS		0	1	935		0	1	925
Contingency	25	%		0		234		0		231
TOTAL O&M COST				0		1,169		0		1,168

* Costs are in January 1996 $1,000

TABLE 11 - 35. COST SUMMARY - 300,000 AF; ELECTRIC TRANSMISSION LINES

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	52,920
3B	68,725
5A	33,410
5C	49,085

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
69 kV Substation	120,000	LS	1	120	1	120	1	120	1	120
69 kV Transmission Line	120,800	MI		0	55	6,644		0	50	6,040
230 kV Substation		LS	1	13,000	1	15,000	1	12,000	1	15,000
230 kV Transmission Line	240,200	MI	80	19,216	80	19,216	40	9,608	40	9,608
Land Acquisition	10,000	AC	1,000	10,000	1,400	14,000	500	5,000	850	8,500
SUBTOTAL				42,336		64,980		26,728		39,268
Contingency	25	%		10,584		13,745		6,682		9,817
TOTAL CAPITAL COST				52,920		68,725		33,410		49,085

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** Included with Pumping Plant and Power Generation/Pressure Control Facilities Operation and Maintenance Costs

TABLE 11 - 36. COST SUMMARY - 300,000 AF; WATER TREATMENT

SUMMARY OF COSTS*		
CORRIDOR	CAPITAL	O&M
3A	197,400	18,100
3B	197,400	18,100
5A	197,400	18,100
5C	197,400	18,100

CAPITAL COSTS										
			CORRIDORS							
	UNIT		3A		3B		5A		5C	
ITEM	COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
TOTAL CAPITAL COST	759**	AF	260,100	197,400	260,100	197,400	260,100	197,400	260,100	197,400

OPERATION AND MAINTENANCE COSTS										
O&M and Replacement	69.5**	AF	260,100	18,100	260,100	18,100	260,100	18,100	260,100	18,100

* Costs are in January 1996 $1,000

** Includes contingency and indirect cost allowances. Based on delivered water volume.

TABLE 11 - 37. COST SUMMARY - 300,000 AF; ENVIRONMENTAL PERMITTING AND MITIGATION

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	12,955
3B	13,830
5A	9,749
5C	17,199

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
Environmental Permitting	Varies	LS	1	2,664	1	2,664	1	2,149	1	2,659
Environmental Mitigation	Varies	LS	1	7,700	1	8,400	1	5,650	1	11,100
SUBTOTAL				10,364		11,064		7,799		13,759
Contingency	25	%		2,591		2,766		1,950		3,440
TOTAL CAPITAL COST				12,955		13,830		8,749		17,199

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** None are considered

Cost Summary Tables--400,000 AF Transfer

TABLE 11 - 3B. COST SUMMARY - 400,000 AF; CANALS

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	87,576
3B	87,576
5A	58,985
5C	49,284

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
Turnout	1,170,000	LS	1	1,170	1	1,170	1	1,170	1	1,170
Concrete Lined Canal	66	LF	489,000	32,274	489,000	32,274	296,500	19,569	234,000	15,444
Inverted Siphon	Varies	LS	1	18,396	1	18,396	1	15,803	1	14,417
Under Crossing	Varies	LS	1	1,221	1	1,221	1	396	1	396
Land Acquisition	10,000	AC	1,700	17,000	1,700	17,000	1,025	10,250	800	8,000
SUBTOTAL				**70,061**		**70,061**		**47,188**		**39,427**
Contingency	25	%		17,515		17,515		11,797		9,857
TOTAL CAPITAL COST				**87,576**		**87,576**		**58,985**		**49,284**

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** Included with Pipeline Operation and Maintenance Costs

TABLE 11 - 39. COST SUMMARY - 400,000 AF; PIPELINES

SUMMARY OF COSTS*		
CORRIDOR	CAPITAL	O&M
3A	289,392	500
3B	335,056	500
5A	227,199	500
5C	625,198	500

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
108" -Dia. Pipe (33ksi)										
0.5" (1/2") Wall Pipe	340	LF	23,180	7,881	98,800	33,932	94,500	32,130	213,320	72,529
0.625" (5/8") Wall Pipe	440	LF	19,600	8,624	33,300	14,652	23,800	10,472	102,440	45,074
0.750" (3/4") Wall Pipe	530	LF	67,600	35,828	31,200	16,536	19,500	10,335	53,300	28,249
0.875" (7/8") Wall Pipe	650	LF	22,700	14,755	19,500	12,675	12,100	7,865	64,400	41,860
1.0" (1") Wall Pipe	1,020	LF	21,100	21,522	25,300	25,806	16,400	16,728	5,300	5,406
1.125" (1-1/8") Wall Pipe	1,140	LF	22,700	25,878	18,000	20,520	0	0	20,600	23,484
Installation/Welding/Joints	160	LF	176,880	28,301	227,100	36,336	166,300	26,608	459,360	73,498
Trenching										
Open - Cut Excavation	120	LF	106,840	12,821	105,210	12,625	61,886	7,426	265,800	31,896
Open - Cut Backfill	192	LF	106,840	20,513	105,210	20,200	61,886	11,882	265,800	51,034
Shored Excavation	240	LF	70,050	16,812	116,550	27,972	92,280	22,150	169,800	40,752
Shored Backfill	133	LF	70,050	9,317	116,550	15,501	92,280	12,275	169,800	22,583
Accessories/Specials										
Appurtenances	31	LF	176,880	5,413	227,100	6,949	166,300	5,089	459,360	14,056
Fault Crossing	20,000	EA		0		0		0		0
Highway Crossings	1,600	LF	150	240	300	480	150	240	4,250	6,800
Railroad Crossings	1,600	LF		0		0		0	450	720
River Crossings	1,700	LF	5,450	9,265	2,650	4,505	2,350	3,995	2,500	4,250
Surface/Utilities	50	LF	176,880	8,844	227,100	11,355	166,300	8,315	459,360	22,968
Land Acquisition	10,000	AC	550	5,500	700	7,000	525	5,250	1,400	14,000
San Vincente Outfall Structure	1,000,000	LS		0	1	1,000	1	1,000	1	1,000
SUBTOTAL				**231,513**		**268,045**		**181,759**		**500,158**
Contingency	25	%		57,878		67,011		45,440		125,040
TOTAL CAPITAL COST				**289,392**		**335,056**		**227,199**		**625,198**

OPERATION AND MAINTENANCE COSTS										
Operation and Maintenance	400,000	LS	1	400	1	400	1	400	1	400
Contingency	25	%		100		100		100		100
TOTAL O&M COST				**500**		**500**		**500**		**500**

* Costs are in January 1998 $1,000

TABLE 11 - 40. COST SUMMARY - 400,000 AF; TUNNELS

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	1,063,784
3B	453,307
5A	857,081
5C	88,461

CAPITAL COSTS

ITEM	UNIT COST	UNIT	CORRIDORS							
			3A		3B		5A		5C	
			QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
Corridor 3A	3,070	LF	230,420	707,389		0		0		0
Corridor 3B	2,179	LF		0	138,200	301,138		0		0
Corridor 5A	2,642	LF		0		0	215,640	569,721		0
Corridor 5C	1,589	LF		0		0		0	36,900	58,634
Land Acquisition	10,000	AC	270	2,700	160	1,600	250	2,500	50	500
Contingency	50	%		353,695		150,569		284,860		29,317
TOTAL CAPITAL COST				1,063,784		453,307		857,081		88,461

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** Included with Pipeline Operation and Maintenance Costs

TABLE 11 - 41. COST SUMMARY - 400,000 AF: PUMPING PLANTS

SUMMARY OF COSTS*		
CORRIDOR	Capital	O&M
3A	111,556	1,375
3B	160,344	2,613
5A	78,788	1,375
5C	106,088	2,613

CAPITAL COSTS										
			CORRIDORS							
	UNIT		3A		3B		5A		5C	
ITEM	COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
800' TDH Plant										
Civil-Structural										
Earth Excavation	3.00	CY	12,000	36	12,000	36	12,000	36	12,000	36
Rock Excavation	20.00	CY	17,000	340	17,000	340	17,000	340	17,000	340
Compacted Backfill	8.00	CY	29,000	232	29,000	232	29,000	232	29,000	232
Reinforced Concrete	350	CY	20,000	7,000	20,000	7,000	20,000	7,000	20,000	7,000
Superstructure	75.00	SF	11,500	863	11,500	863	11,500	863	11,500	863
Miscellaneous Metals	2,600	TN	80	208	80	208	80	208	80	208
Steel Piping / Bifurcation	1,300	LF	675	878	675	878	675	878	675	878
Cranes	360,000	LS	1	360	1	360	1	360	1	360
Elevator	150,000	LS	1	150	1	150	1	150	1	150
Architectural	75,000	LS	1	75	1	75	1	75	1	75
Sitework	100,000	LS	1	100	1	100	1	100	1	100
Access Road	450,000	MI	5	2,250	5	2,250	5	2,250	5	2,250
Mechanical										
Pumps	900,000	EA	5	4,500	5	4,500	5	4,500	5	4,500
Discharge Valves	130,000	EA	5	650	5	650	5	650	5	650
BOP Mechanical Systems	450,000	LS	1	450	1	450	1	450	1	450
Electrical										
Motors	1,400,000	EA	5	7,000	5	7,000	5	7,000	5	7,000
BOP Electrical Systems	1,200,000	LS	1	1,200	1	1,200	1	1,200	1	1,200
Plant Substation	3,300,000	LS	1	3,300	1	3,300	1	3,300	1	3,300
Forebay										
Earth Excavation	3.00	CY	80,000	240	80,000	240	80,000	240	80,000	240
Compacted Backfill	8.00	CY	80,000	640	80,000	640	80,000	640	80,000	640
Asphaltic Concrete Liner	18.00	SY	33,000	594	33,000	594	33,000	594	33,000	594
Outfall Structure	100,000	LS	1	100	1	100	1	100	1	100
Spillway Structure & Pipeline	175,000	LS	1	175	1	175	1	175	1	175
Sitework	75,000	LS	1	75	1	75	1	75	1	75
Land Acquisition	10,000	AC	10	100	10	100	10	100	10	100
SUBTOTAL				31,515		31,515		31,515		31,515
No. Required			2		4		2		5	
800' FACILITY TOTAL				63,030		126,060		63,030		157,575

* Costs are in January 1996 $1,000

TABLE 11 - 41. COST SUMMARY - 400,000 AF; PUMPING PLANTS (Continued)

CAPITAL COSTS*										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
400' TDH Plant										
Civil-Structural										
Earth Excavation	3.00	CY	12,000	36	12,000	36				
Rock Excavation	20.00	CY	17,000	340	17,000	340				
Compacted Backfill	8.00	CY	29,000	232	29,000	232				
Reinforced Concrete	350	CY	20,000	7,000	20,000	7,000				
Superstructure	75.00	SF	11,500	863	11,500	863				
Miscellaneous Metals	2,600	TN	80	208	80	208				
Steel Piping / Bifurcation	1,300	LF	675	878	675	878				
Cranes	380,000	LS	1	380	1	380				
Elevator	150,000	LS	1	150	1	150				
Architectural	75,000	LS	1	75	1	75				
Sitework	100,000	LS	1	100	1	100				
Access Road	450,000	MI	5	2,250	5	2,250				
Mechanical										
Pumps	600,000	EA	5	3,000	5	3,000				
Discharge Valves	90,000	EA	5	450	5	450				
BOP Mechanical Systems	400,000	LS	1	400	1	400				
Electrical										
Motors	970,000	EA	5	4,850	5	4,850				
BOP Electrical Systems	850,000	LS	1	850	1	850				
Plant Substation	2,250,000	LS	1	2,250	1	2,250				
Forebay										
Earth Excavation	3.00	CY	80,000	240	80,000	240				
Compacted Backfill	8.00	CY	80,000	640	80,000	640				
Arphaltic Concrete Liner	18.00	SY	33,000	594	33,000	594				
Outfall Structure	100,000	LS	1	100	1	100				
Spillway Structure & Pipeline	175,000	LS	1	175	1	175				
Sitework	75,000	LS	1	75	1	75				
Land Acquisition	10,000	AC	10	100	10	100				
400' FACILITY TOTAL			1	**26,215**	1	**26,215**		**0**		**0**
800' FACILITY TOTAL				**63,030**		**126,060**		**63,030**		**157,575**
PUMPING PLANT SUBTOTAL				**89,245**		**152,275**		**63,030**		**157,575**
Contingency	25	%		22,311		38,069		15,758		39,394
TOTAL CAPITAL COST				**111,556**		**190,344**		**78,788**		**196,969**

OPERATION AND MAINTENANCE COSTS										
O&M and Replacement	Varies	LS	1	1,100	1	2,090	1	1,100	1	2,090
Contingency	25	%		275		523		275		523
TOTAL O&M COST				**1,375**		**2,613**		**1,375**		**2,613**

* Costs are in January 1998 $1,000

TABLE 11 - 42. COST SUMMARY - 400,000 AF; POWER GENERATING / PRESSURE CONTROL FACILITIES

SUMMARY OF COSTS*		
CORRIDOR	CAPITAL	O&M
3A	0	0
3B	114,827	1,169
5A	0	0
5C	108,731	1,156

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
800' Net Head Plant										
Powerhouse										
Civil-Structural										
Earth Excavation	3.00	CY			7,000	21			7,000	21
Rock Excavation	20.00	CY			8,000	160			8,000	160
Compacted Backfill	8.00	CY			15,000	120			15,000	120
Reinforced Concrete	350	CY			15,400	5,390			15,400	5,390
Superstructure	75.00	SF			15,600	1,163			15,500	1,163
Miscellaneous Metals	2,600	TN			40	104			40	104
Steel Piping / Bifurcation	2,000	LF			370	740			370	740
Cranes	275,000	LS			1	275			1	275
Architectural	75,000	LS			1	75			1	75
Sitework	100,000	LS			1	100			1	100
Access Road	450,000	MI			5	2,250			5	2,250
Mechanical										
Turbine	4,600,000	LS			1	4,600			1	4,600
Inlet Valves	690,000	EA			4	2,760			4	2,760
Sleeve Valves	530,000	EA			3	1,590			3	1,590
BOP Mechanical Systems	500,000	LS			1	500			1	500
Electrical										
Generator	4,400,000	LS			1	4,400			1	4,400
BOP Electrical Systems	780,000	LS			1	780			1	780
Plant Substation	900,000	LS			1	900			1	900
Forebay										
Earth Excavation	3.00	CY			80,000	240			80,000	240
Compacted Backfill	8.00	CY			80,000	640			80,000	640
Asphaltic Conc. Liner	18.00	SY			33,000	594			33,000	594
Intake Structure	700,000	LS			1	700			1	700
Spillway Structure & Pipeline	175,000	LS			1	175			1	175
Sitework	75,000	LS			1	75			1	75
Land Acquisition	10,000	AC			10	100			10	100
SUBTOTAL						28,482				28,482
No. Required					1				3	
800' FACILITY TOTAL						28,482				85,385
1450' Underground PH	63,400,000	LS			1	63,400				
SUBTOTAL						91,882				85,385
Contingency	25	%				22,965				21,346
TOTAL CAPITAL COST						114,827				108,731

OPERATION AND MAINTENANCE COSTS										
O&M and Replacement	Varies	LS		0	1	935		0	1	925
Contingency	25	%		0		234		0		231
TOTAL O&M COST				0		1,169		0		1,156

* Costs are in January 1996 $1,000

TABLE 11 - 43. COST SUMMARY - 400,000 AF; ELECTRIC TRANSMISSION LINES

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	52,920
3B	68,725
5A	33,410
5C	49,085

CAPITAL COSTS

ITEM	UNIT COST	UNIT	CORRIDORS							
			3A		3B		5A		5C	
			QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
69 kV Substation	120,000	LS	1	120	1	120	1	120	1	120
69 kV Transmission Line	120,800	MI		0	55	6,644		0	50	6,040
230 kV Substation		LS	1	13,000	1	15,000	1	12,000	1	15,000
230 kV Transmission Line	240,200	MI	80	19,216	80	19,216	40	9,608	40	9,608
Land Acquisition	10,000	AC	1,000	10,000	1,400	14,000	500	5,000	850	8,500
SUBTOTAL				42,336		54,980		26,728		39,268
Contingency	25	%		10,584		13,745		6,682		9,817
TOTAL CAPITAL COST				52,920		68,725		33,410		49,085

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1986 $1,000

** Included with Pumping Plant and Power Generation/Pressure Control Facilities Operation and Maintenance Costs

TABLE 11 - 44. COST SUMMARY - 400,000 AF; WATER TREATMENT

SUMMARY OF COSTS*		
CORRIDOR	CAPITAL	O&M
3A	263,200	24,100
3B	263,200	24,100
5A	263,200	24,100
5C	263,200	24,100

CAPITAL COSTS										
			CORRIDORS							
	UNIT		3A		3B		5A		5C	
ITEM	COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
TOTAL CAPITAL COST	759**	AF	346,800	263,200	346,800	263,200	346,800	263,200	346,800	263,200

OPERATION AND MAINTENANCE COSTS										
O&M and Replacement	69.5**	AF	346,800	24,100	346,800	24,100	346,800	24,100	346,800	24,100

* Costs are in January 1996 $1,000

** Includes contingency and indirect cost allowances. Based on delivered water volume.

TABLE 11 - 45. COST SUMMARY - 400,000 AF; ENVIRONMENTAL PERMITTING AND MITIGATION

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	12,955
3B	13,830
5A	9,749
5C	17,199

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
Environmental Permitting	Varies	LS	1	2,664	1	2,664	1	2,149	1	2,659
Environmental Mitigation	Varies	LS	1	7,700	1	8,400	1	5,650	1	11,100
SUBTOTAL				**10,364**		**11,064**		**7,799**		**13,759**
Contingency	25	%		2,591		2,766		1,950		3,440
TOTAL CAPITAL COST				**12,955**		**13,830**		**9,749**		**17,199**

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** None are considered

Cost Summary Tables--500,000 AF Transfer

TABLE 11 - 46. COST SUMMARY - 500,000 AF; CANALS

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	90,480
3B	90,480
5A	61,275
5C	51,279

CAPITAL COSTS										
ITEM	UNIT COST	UNIT	CORRIDORS							
			3A		3B		5A		5C	
			QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
Turnout	1,256,000	LS	1	1,256	1	1,256	1	1,256	1	1,256
Concrete Lined Canal	68	LF	489,000	33,252	489,000	33,252	296,500	20,162	234,000	15,912
Inverted Siphon	Varies	LS	1	19,655	1	19,655	1	16,956	1	15,459
Under Crossing	Varies	LS	1	1,221	1	1,221	1	396	1	396
Land Acquisition	10,000	AC	1,700	17,000	1,700	17,000	1,025	10,250	800	8,000
SUBTOTAL				**72,384**		**72,384**		**49,020**		**41,023**
Contingency	25	%		18,096		18,096		12,255		10,256
TOTAL CAPITAL COST				**90,480**		**90,480**		**61,276**		**51,279**

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** Included with Pipeline Operation and Maintenance Costs

TABLE 11 - 47. COST SUMMARY - 500,000 AF; PIPELINES

SUMMARY OF COSTS*		
CORRIDOR	CAPITAL	O&M
3A	349,044	500
3B	394,261	500
5A	265,129	500
5C	748,120	500

CAPITAL COSTS										
			CORRIDORS							
	UNIT		3A		3B		5A		5C	
ITEM	COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
120" -Dia. Pipe (33ksi)										
0.5" (1/2") Wall Pipe	380	LF	9,300	3,534	74,800	28,424	70,900	26,942	128,000	48,640
0.625" (5/8") Wall Pipe	490	LF	13,900	6,811	26,000	12,260	23,600	11,564	85,300	41,797
0.750" (3/4") Wall Pipe	590	LF	19,600	11,564	33,300	19,647	23,800	14,042	102,440	60,440
0.875" (7/8") Wall Pipe	730	LF	67,600	49,348	31,200	22,776	19,500	14,235	53,300	38,909
1.0" (1") Wall Pipe	1,140	LF	22,700	25,878	19,500	22,230	12,100	13,794	64,400	73,416
1.125" (1-1/8") Wall Pipe	1,270	LF	21,100	26,797	25,300	32,131	16,400	20,828	5,300	6,731
1.25" (1-1/8") Wall Pipe	1,400	LF	22,700	31,780	18,000	25,200	0	0	20,600	28,840
Installation/Welding/Joints	170	LF	176,900	30,073	227,100	38,607	166,300	28,271	459,340	78,088
Trenching										
Open - Cut Excavation	130	LF	106,840	13,889	105,210	13,677	61,888	8,045	265,800	34,554
Open - Cut Backfill	200	LF	106,840	21,368	105,210	21,042	61,888	12,377	265,800	53,160
Shored Excavation	270	LF	70,050	18,914	116,550	31,469	92,280	24,916	169,800	45,846
Shored Backfill	143	LF	70,050	10,017	116,550	16,667	92,280	13,197	169,800	24,281
Accessories/Specials										
Appurtenances	31	LF	176,900	5,413	227,100	6,949	166,300	5,089	459,340	14,056
Fault Crossing	20,000	EA		0		0		0		0
Highway Crossings	1,600	LF	150	240	300	480	150	240	4,250	6,800
Railroad Crossings	1,600	LF		0		0		0	450	720
River Crossings	1,700	LF	5,450	9,265	2,650	4,505	2,350	3,995	2,500	4,250
Surface/Utilities	60	LF	176,880	8,844	227,100	11,355	166,300	8,315	459,360	22,968
Land Acquisition	10,000	AC	550	5,500	700	7,000	525	5,250	1,400	14,000
San Vincente Outfall Structure	1,000,000	LS		0	1	1,000	1	1,000	1	1,000
SUBTOTAL				279,235		315,409		212,103		598,496
Contingency	25	%		69,809		78,852		53,026		149,624
TOTAL CAPITAL COST				349,044		394,261		265,129		748,120

OPERATION AND MAINTENANCE COSTS										
Operation and Maintenance	400,000	LS	1	400	1	400	1	400	1	400
Contingency	25	%		100		100		100		100
TOTAL O&M COST				500		500		500		500

* Costs are in January 1996 $1,000

TABLE 11 - 48. COST SUMMARY - 500,000 AF; TUNNELS

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	1,063,784
3B	453,307
5A	857,081
5C	88,451

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
Corridor 3A	3,070	LF	230,420	707,389		0		0		0
Corridor 3B	2,179	LF		0	138,200	301,138		0		0
Corridor 5A	2,642	LF		0		0	215,640	569,721		0
Corridor 5C	1,589	LF		0		0		0	36,900	58,634
Land Acquisition	10,000	AC	270	2,700	160	1,600	250	2,500	50	500
Contingency	50	%		353,695		150,569		284,860		29,317
TOTAL CAPITAL COST				1,063,784		453,307		857,081		88,451

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** Included with Pipeline Operation and Maintenance Costs

TABLE 11 - 48. COST SUMMARY - 500,000 AF; PUMPING PLANTS

SUMMARY OF COSTS*		
CORRIDOR	Capital	O&M
3A	124,038	1,375
3B	216,863	2,613
5A	92,625	1,375
5C	232,063	2,613

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
800' TDH Plant										
Civil-Structural										
Earth Excavation	3.00	CY	14,400	43	14,400	43	14,400	43	14,400	43
Rock Excavation	20.00	CY	20,400	408	20,400	408	20,400	408	20,400	408
Compacted Backfill	8.00	CY	34,800	278	34,800	278	34,800	278	34,800	278
Reinforced Concrete	350	CY	24,000	8,400	24,000	8,400	24,000	8,400	24,000	8,400
Superstructure	75.00	SF	12,600	945	12,600	945	12,600	945	12,600	945
Miscellaneous Metals	2,800	TN	85	247	85	247	85	247	85	247
Steel Piping / Bifurcation	1,300	LF	835	1,088	835	1,088	835	1,088	835	1,088
Cranes	380,000	LS	1	380	1	380	1	380	1	380
Elevator	150,000	LS	1	150	1	150	1	150	1	150
Architectural	75,000	LS	1	75	1	75	1	75	1	75
Sitework	100,000	LS	1	100	1	100	1	100	1	100
Access Road	450,000	MI	5	2,250	5	2,250	5	2,250	5	2,250
Mechanical										
Pumps	900,000	EA	6	5,400	6	5,400	6	5,400	6	5,400
Discharge Valves	130,000	EA	6	780	6	780	6	780	6	780
BOP Mechanical Systems	540,000	LS	1	540	1	540	1	540	1	540
Electrical										
Motors	1,400,000	EA	6	8,400	6	8,400	6	8,400	6	8,400
BOP Electrical Systems	1,420,000	LS	1	1,420	1	1,420	1	1,420	1	1,420
Plant Substation	3,900,000	LS	1	3,900	1	3,900	1	3,900	1	3,900
Forebay										
Earth Excavation	3.00	CY	100,000	300	100,000	300	100,000	300	100,000	300
Compacted Backfill	8.00	CY	100,000	800	100,000	800	100,000	800	100,000	800
Asphaltic Concrete Liner	18.00	SY	41,000	738	41,000	738	41,000	738	41,000	738
Outlet Structure	115,000	LS	1	115	1	115	1	115	1	115
Spillway Structure & Pipeline	200,000	LS	1	200	1	200	1	200	1	200
Sitework	85,000	LS	1	85	1	85	1	85	1	85
Land Acquisition	10,000	AC	10	100	10	100	10	100	10	100
SUBTOTAL				37,130		37,130		37,130		37,130
No. Required			2		4		2		5	
800' FACILITY TOTAL				74,260		148,520		74,260		185,651

* Costs are in January 1998 $1,000

TABLE 11 - 48. COST SUMMARY - 500,000 AF; PUMPING PLANTS (Continued)

CAPITAL COSTS*										
			CORRIDORS							
	UNIT		3A		3B		5A		5C	
ITEM	COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
400' TDH Plant										
Civil-Structural										
Earth Excavation	3.00	CY	14,400	43	14,400	43				
Rock Excavation	20.00	CY	20,400	408	20,400	408				
Compacted Backfill	8.00	CY	34,800	278	34,800	278				
Reinforced Concrete	350	CY	24,000	8,400	24,000	8,400				
Superstructure	75.00	SF	12,600	945	12,600	945				
Miscellaneous Metals	2,600	TN	95	247	95	247				
Steel Piping / Bifurcation	1,300	LF	835	1,086	835	1,086				
Cranes	380,000	LS	1	380	1	380				
Elevator	150,000	LS	1	150	1	150				
Architectural	75,000	LS	1	75	1	75				
Sitework	100,000	LS	1	100	1	100				
Access Road	450,000	MI	5	2,250	5	2,250				
Mechanical										
Pumps	600,000	EA	6	3,600	6	3,600				
Discharge Valves	90,000	EA	6	540	6	540				
BOP Mechanical Systems	480,000	LS	1	480	1	480				
Electrical										
Motors	970,000	EA	6		6					
BOP Electrical Systems	1,010,000	LS	1	1,010	1	1,010				
Plant Substation	2,650,000	LS	1	2,650	1	2,650				
Forebay										
Earth Excavation	3.00	CY	100,000	300	100,000	300				
Compacted Backfill	8.00	CY	100,000	800	100,000	800				
Asphaltic Concrete Liner	18.00	SY	41,000	738	41,000	738				
Outfall Structure	115,000	LS	1	115	1	115				
Spillway Structure & Pipeline	200,000	LS	1	200	1	200				
Sitework	95,000	LS	1	95	1	95				
Land Acquisition	10,000	AC	10	100	10	100				
400' FACILITY TOTAL			1	**24,970**	1	**24,970**		**0**		**0**
800' FACILITY TOTAL				**74,280**		**148,520**		**74,260**		**185,651**
PUMPING PLANT SUBTOTAL				**99,230**		**173,491**		**74,260**		**185,651**
Contingency	25	%		24,808		43,373		18,565		46,413
PUMPING PLANTS TOTAL				**124,038**		**216,863**		**92,825**		**232,063**

OPERATION AND MAINTENANCE COSTS										
O&M and Replacement	Varies	LS	1	1,100	1	2,000	1	1,100	1	2,000
Contingency	25	%		275		523		275		523
TOTAL O&M COST				**1,375**		**2,813**		**1,375**		**2,813**

* Costs are in January 1998 $1,000

TABLE 11 - 50. COST SUMMARY - 500,000 AF; POWER GENERATING / PRESSURE CONTROL FACILITIES

SUMMARY OF COSTS*		
CORRIDOR	Capital	O&M
3A	0	0
3B	140,718	1,169
5A	0	0
5C	124,779	1,158

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
900' Net Head Plant										
Powerhouse										
Civil-Structural										
Earth Excavation	3.00	CY			7,000	21			7,000	21
Rock Excavation	20.00	CY			8,000	160			8,000	160
Compacted Backfill	8.00	CY			15,000	120			15,000	120
Reinforced Concrete	350	CY			15,400	5,390			15,400	5,390
Superstructure	75.00	SF			15,500	1,163			15,500	1,163
Miscellaneous Metals	2,600	TN			40	104			40	104
Steel Piping / Bifurcation	2,200	LF			370	814			370	814
Cranes	300,000	LS			1	300			1	300
Architectural	75,000	LS			1	75			1	75
Sitework	100,000	LS			1	100			1	100
Access Road	450,000	MI			5	2,250			5	2,250
Mechanical										
Turbine	6,440,000	LS			1	6,440			1	6,440
Inlet Valves	920,000	EA			4	3,680			4	3,680
Sleeve Valves	690,000	EA			3	2,070			3	2,070
BOP Mechanical Systems	550,000	LS			1	550			1	550
Electrical										
Generator	5,060,000	LS			1	5,060			1	5,060
BOP Electrical Systems	910,000	LS			1	910			1	910
Plant Substation	1,035,000	LS			1	1,035			1	1,035
Forebay										
Earth Excavation	3.00	CY			100,000	300			100,000	300
Compacted Backfill	8.00	CY			100,000	800			100,000	800
Asphaltic Conc. Liner	18.00	SY			41,000	738			41,000	738
Intake Structure	800,000	LS			1	800			1	800
Spillway Structure & Pipeline	200,000	LS			1	200			1	200
Sitework	95,000	LS			1	95			1	95
Land Acquisition	10,000	AC			10	100			10	100
SUBTOTAL						33,276				33,276
No. Required					1				3	
900' FACILITY TOTAL						33,276				99,824
1450' Underground Pit	78,300,000	LS			1	78,300				
SUBTOTAL						112,575				99,824
Contingency	25	%				28,144				24,956
TOTAL CAPITAL COST						140,718				124,779

OPERATION AND MAINTENANCE COSTS										
O&M and Replacement	Varies	LS		0	1	935		0	1	925
Contingency	25	%		0		234		0		231
TOTAL O&M COST				0		1,169		0		1,158

* Costs are in January 1996 $1,000

TABLE 11 - 51. COST SUMMARY - 600,000 AF; ELECTRIC TRANSMISSION LINES

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	52,920
3B	68,725
5A	33,410
5C	49,085

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
69 kV Substation	120,000	LS	1	120	1	120	1	120	1	120
69 kV Transmission Line	120,800	MI		0	55	6,644		0	50	6,040
230 kV Substation		LS	1	13,000	1	15,000	1	12,000	1	15,000
230 kV Transmission Line	240,200	MI	80	19,216	80	19,216	40	9,608	40	9,608
Land Acquisition	10,000	AC	1,000	10,000	1,400	14,000	500	5,000	850	8,500
SUBTOTAL				42,336		54,980		26,728		39,268
Contingency	25	%		10,584		13,745		6,682		9,817
TOTAL CAPITAL COST				52,920		68,725		33,410		49,085

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** Included with Pumping Plant and Power Generation/Pressure Control Facilities Operation and Maintenance Costs

TABLE 11 - 52. COST SUMMARY - 500,000 AF; WATER TREATMENT

SUMMARY OF COSTS*		
CORRIDOR	CAPITAL	O&M
3A	329,000	30,100
3B	329,000	30,100
5A	329,000	30,100
5C	329,000	30,100

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
TOTAL CAPITAL COST	769**	AF	433,500	329,000	433,500	329,000	433,500	329,000	433,500	329,000

OPERATION AND MAINTENANCE COSTS										
O&M and Replacement	69.5**	AF	433,500	30,100	433,500	30,100	433,500	30,100	433,500	30,100

* Costs are in January 1996 $1,000

** Includes contingency and indirect cost allowances. Based on delivered water volume.

TABLE 11 - 53. COST SUMMARY - 500,000 AF; ENVIRONMENTAL PERMITTING AND MITIGATION

SUMMARY OF COSTS*	
CORRIDOR	CAPITAL
3A	12,955
3B	13,830
5A	9,749
5C	17,199

CAPITAL COSTS										
			CORRIDORS							
			3A		3B		5A		5C	
ITEM	UNIT COST	UNIT	QTY	COST*	QTY	COST*	QTY	COST*	QTY	COST*
Environmental Permitting	Varies	LS	1	2,664	1	2,664	1	2,149	1	2,659
Environmental Mitigation	Varies	LS	1	7,700	1	8,400	1	5,650	1	11,100
SUBTOTAL				**10,364**		**11,064**		**7,799**		**13,759**
Contingency	25	%		2,591		2,766		1,950		3,440
TOTAL CAPITAL COST				**12,955**		**13,830**		**9,749**		**17,199**

OPERATION AND MAINTENANCE COSTS**

* Costs are in January 1996 $1,000

** None are considered

12.0 Staging Opportunities

12.1 Introduction

This section identifies possible strategies to stage construction of the alternative corridors in an effort to defer capital cost.

12.2 Evaluation of Staging

Corridor 1A

Corridor 1A is an excellent candidate for staging of construction. Stage 1 would consist of modifications to the CRA to deliver about 200,000 AF. Later, as demands increase, Stage 2 would consist of construction of a parallel system to the existing CRA sized to deliver 300,000 AF, for a total increased capacity of 500,000 AF. Detailed descriptions of the components associated with Corridor 1A are presented in Section 7.0 of this report. For cash flow projections, Stage 2 is considered to become operational 10 years after Stage 1.

Corridor 3A

Corridor 3A consists of some 90 miles of canal, over 30 miles of pipeline, and about 40 miles of tunnel. Three pumping plants are also associated with Corridor 3A. The evaluation for staged construction of Corridor 3A will examine the opportunity for phased construction of each of these major components. The estimated capital costs for the canal component presented in Section 11.0 is less than 10 percent of the total capital cost for Corridor 3A for all delivery options. Furthermore, the canal component increases only by about 15 percent for the range of transfer volumes considered. The canal component thus does not offer significant opportunities for staging of construction to defer significant capital costs.

Although representing a slightly larger percentage of total capital cost, pipelines still do not offer a significant opportunity for staging. In fact, the construction of two smaller diameter pipelines would result in a significant increase in capital cost. For example, two 66 inch diameter pipes are required to equal the capacity of one 96 inch pipe. The cost for the pipe material for two 66 inch pipes will be approximately the same as a 96 inch due to reduced plate thickness for the same pressure class as a result of smaller diameter. The trenching, installation, and appurtenances for one 66 inch pipe will be 75 to 90 percent of these costs for one 96 inch pipe. Thus, the installation costs

of two 66 inch pipes would be 150 to 180 percent of one 96 inch pipe. Additional right-of-way would also be required. Given that trenching, installation, and appurtenances are about 50 percent of the total constructed cost of a pipeline, two 66 inch pipes would cost about 25 to 40 percent more than one 96 inch pipe in current year costs.

The tunnel component is the single biggest cost component for Corridor 3A. For constructibility reasons, a minimum excavated tunnel of 12 feet diameter has been selected. This tunnel diameter, even when lined for geologic or internal pressure considerations, has sufficient hydraulic capacity to accommodate all flows up to and including the design flow for a 500,000 AF transfer. Therefore, tunnel costs are independent of proposed transfer volume and no opportunity to stage tunnel construction exists.

Pumping plants are good candidates for staging. Bays can be added to the pumphouse to accommodate additional pumps as the volume of transfer water increases. The pumping plant costs again, however, represent less than 10 percent of the total capital cost, and staging would not significantly defer capital costs.

Opportunities for classical staging on Corridor 3A that result in significant cost deferral do not exist.

Corridor 3B

Corridor 3B has component characteristics similar to 3A except the tunnel component is less than the pipeline. Corridor 3B does have considerably more pumping head and thus has two more pumping plants than 3A. Two cash flow scenarios were developed for Corridor 3B. Cash flow 3B.1 is based on full initial development of a 500,000 AF system. Cash flow 3B.2 is based on deferring capital costs of the pipeline and pumping plant components. Initially, a 250,000 AF system will be operational by the year 2012 with an expansion to 500,000 AF 10 years later.

Corridor 5A

Because of its long tunnel component and low pumping head, Corridor 5A offers no significant opportunity for staging of construction.

Corridor 5C

Corridor 5C is principally comprised of pipeline. Similar to Corridor 3B, Corridor 5C has a large pumping head and five pumping plants. Two cash flow scenarios were developed for Corridor 5C. Cash flow 5C.1 is based on full initial development of a 500,000 AF system. Cash flow 5C.2 is based on deferring capital costs of pipeline and

pumping plant components. Initially, a 250,000 AF system will be operational by the year 2012 with an expansion to 500,000 AF 10 years later.

12.3 Estimated Cash Flows

Summaries of estimated capital and annual costs and capital cost cash flow estimates for Corridors 3A, 3B, 5A, and 5C are presented in Tables 12-1 and 12-2 for annual transfer volumes of 300,000 AF and 400,000 AF, respectively. No staging of project development was considered for these transfer volumes. The same information is provided in Table 12-3 for an annual transfer volume of 500,000 AF. In Table 12-3, potential staged project development is also considered for Corridors 1A, 3B, and 5C. The estimated cash flows of capital costs are based on the capital cost allocation indicated in Table 12-4.

The estimated cash flows are based on the following sequence and duration of events:

EIR/EIS	36 months
Design	36 months
Construction	84 months

Based on a target on-line date in 2012 (as directed by Authority staff), the EIR/EIS must commence not later than the year 1999.

Table 12-1
Estimated Cash Flows--300,000 AF Transfer*

Escalation	0%			
Case	300,000 AF			
	Cash Flow Scenario			
Item	3A ($1,000)	3B ($1,000)	5A ($1,000)	5C ($1,000)
Estimated Capital Costs				
Engineering Stage 1	232,684	172,612	182,225	151,754
Construction Stage 1	1,515,725	1,110,544	1,191,635	979,895
Land Acquisition	35,500	40,200	23,200	31,800
Engineering Stage 2	0	0	0	0
Construction Stage 2	0	0	0	0
Treatment Stage 1	197,400	197,400	197,400	197,400
Treatment Stage 2	0	0	0	0
Total Capital Cost	1,981,309	1,520,756	1,594,460	1,360,849
Estimated Annual Costs				
O&M Stage 1 (Yr 2012)	1,875	4,282	1,875	4,271
O&M Stage 2 (Yr 2022)	0	0	0	0
Total O&M	1,875	4,282	1,875	4,271
Power Stage 1 (Yr 2012)	23,010	31,704	25,113	34,353
Power Stage 2 (Yr 2022)	0	0	0	0
Total Power	23,010	31,704	25,113	34,353
Treatment O&M Stage 1	18,100	18,100	18,100	18,100
Treatment O&M Stage 2	0	0	0	0
Total Treatment O&M	18,100	18,100	18,100	18,100

*All costs are in 1996 dollars.

Table 12-1 (Continued)
Estimated Cash Flows--300,000 AF Transfer

Capital Costs Cash Flow (Escalated Values to Indicated Year)				
	Cash Flow Scenario			
Year	3A ($1,000)	3B ($1,000)	5A ($1,000)	5C ($1,000)
1999	11,634	8,631	9,111	7,588
2000	17,451	12,946	13,667	11,382
2001	17,451	12,946	13,667	11,382
2002	46,736	39,292	35,067	33,363
2003	46,736	39,292	35,067	33,363
2004	46,736	39,292	35,067	33,363
2005	163,207	119,685	128,275	105,577
2006	238,993	175,212	187,857	154,572
2007	238,993	175,212	187,857	154,572
2008	238,993	175,212	187,857	154,572
2009	304,793	241,012	253,657	220,372
2010	304,793	241,012	253,657	220,372
2011	304,793	241,012	253,657	220,372

Table 12-2
Estimated Cash Flows--400,000 AF Transfer*

Escalation	0%			
Case	400,000 AF			
	Cash Flow Scenario			
Item	3A ($1,000)	3B ($1,000)	5A ($1,000)	5C ($1,000)
Estimated Capital Costs				
Engineering Stage 1	242,727	189,550	189,782	169,938
Construction Stage 1	1,582,683	1,223,465	1,242,012	1,101,117
Land Acquisition	35,500	40,200	23,200	31,800
Engineering Stage 2	0	0	0	0
Construction Stage 2	0	0	0	0
Treatment Stage 1	263,200	263,200	263,200	263,200
Treatment Stage 2	0	0	0	0
Total Capital Cost	2,124,110	1,716,415	1,718,194	1,566,055
Estimated Annual Costs				
O&M Stage 1 (Yr 2012)	1,875	4,282	1,875	4,271
O&M Stage 2 (Yr 2022)	0	0	0	0
Total O&M	1,875	4,282	1,875	4,271
Power Stage 1 (Yr 2012)	30,720	42,270	33,483	45,801
Power Stage 2 (Yr 2022)	0	0	0	0
Total Power	30,720	42,270	33,483	45,801
Treatment O&M Stage 1	24,100	24,100	24,100	24,100
Treatment O&M Stage 2	0	0	0	0
Total Treatment O&M	24,100	24,100	24,100	24,100

*All costs are in 1996 dollars.

Table 12-2 (Continued)
Estimated Cash Flows--400,000 AF Transfer

Capital Costs Cash Flow (Escalated Values to Indicated Year)				
	Cash Flow Scenario			
Year	3A ($1,000)	3B ($1,000)	5A ($1,000)	5C ($1,000)
1999	12,136	9,478	9,489	8,497
2000	18,205	14,216	14,234	12,745
2001	18,205	14,216	14,234	12,745
2002	48,242	41,833	36,201	36,091
2003	48,242	41,833	36,201	36,091
2004	48,242	41,833	36,201	36,091
2005	170,405	131,824	133,690	118,609
2006	249,539	192,997	195,791	173,664
2007	249,539	192,997	195,791	173,664
2008	249,539	192,997	195,791	173,664
2009	337,272	280,731	283,524	261,398
2010	337,272	280,731	283,524	261,398
2011	337,272	280,731	283,524	261,398

Table 12-3
Estimated Cash Flows--500,000 AF Transfer*

Escalation	0%						
Case	500,000 AF						
	Cash Flow Scenario						
Item	1A ($1,000)	3A ($1,000)	3B.1 ($1,000)	3B.2 ($1,000)	5A ($1,000)	5C.1 ($1,000)	5C.2 ($1,000)
Estimated Capital Costs							
Engineering Stage 1	102,563	253,983	206,728	159,849	197,920	196,646	135,636
Construction Stage 1	623,751	1,657,721	1,337,984	1,065,660	1,296,269	1,279,176	904,240
Land Acquisition	60,000	35,500	40,200	40,200	23,200	31,800	31,800
Engineering Stage 2	337,442	0	0	71,928	0	0	109,504
Construction Stage 2	2,249,614	0	0	479,518	0	0	730,026
Treatment Stage 1	103,398	329,000	329,000	164,500	329,000	329,000	164,500
Treatment Stage 2	155,097	0	0	164,500	0	0	164,500
Total Capital Cost	3,631,865	2,276,204	1,913,912	2,146,155	1,846,389	1,836,622	2,240,206
Estimated Annual Costs							
O&M Stage 1 (Yr 2012)	390	1,875	4,282	3,854	1,875	4,271	2,136
O&M Stage 2 (Yr 2022)	2,700	0	0	3,854	0	0	2,136
Total O&M	3,090	1,875	4,282	7,708	1,875	4,271	4,271
Power Stage 1 (Yr 2012)	12,764	38,400	52,836	26,418	41,856	57,252	28,626
Power Stage 2 (Yr 2022)	19,146	0	0	26,418	0	0	28,626
Total Power	31,910	38,400	52,836	52,836	41,856	57,252	57,252
Treatment O&M Stage 1	8,834	30,100	30,100	15,050	30,100	30,100	15,050
Treatment O&M Stage 2	13,251	0	0	15,050	0	0	15,050
Total Treatment O&M	22,085	30,100	30,100	30,100	30,100	30,100	30,100

*All costs are in 1996 dollars.

Table 12-3 (Continued)
Estimated Cash Flows--500,000 AF Transfer

Capital Costs Cash Flow (Escalated Values to Indicated Year)							
	Cash Flow Scenario						
Year	1A ($1,000)	3A ($1,000)	3B.1 ($1,000)	3B.2 ($1,000)	5A ($1,000)	5C.1 ($1,000)	5C.2 ($1,000)
1999	5,128	12,699	10,336	7,992	9,896	9,832	6,782
2000	7,692	19,049	15,505	11,989	14,844	14,748	10,173
2001	7,692	19,049	15,505	11,989	14,844	14,748	10,173
2002	35,384	49,931	44,409	37,377	37,421	40,097	30,945
2003	35,384	49,931	44,409	37,377	37,421	40,097	30,945
2004	35,384	49,931	44,409	37,377	37,421	40,097	30,945
2005	67,503	178,471	144,135	114,558	139,523	137,750	97,206
2006	98,691	261,357	211,034	167,841	204,336	201,709	142,418
2007	98,691	261,357	211,034	167,841	204,336	201,709	142,418
2008	98,691	261,357	211,034	167,841	204,336	201,709	142,418
2009	133,157	371,024	320,701	222,675	314,003	311,375	197,251
2010	133,157	371,024	320,701	222,675	314,003	311,375	197,251
2011	133,157	371,024	320,701	222,675	314,003	311,375	197,251
2012	26,995			5,754			8,760
2013	84,361			17,982			27,376
2014	84,361			17,982			27,376
2015	245,208			52,267			79,573
2016	357,689			76,243			116,074
2017	357,689			76,243			116,074
2018	357,689			76,243			116,074
2019	409,388			131,077			170,907
2020	409,388			131,077			170,907
2021	409,388			131,077			170,907

Table 12-4
Capital Cost Allocation

	Capital Cost Allocation in Percent						
	Stage 1 Development				Stage 2 Development		
Year	Engineering	Construction	Treatment	Land Acquisition	Engineering	Construction	Treatment
1	5						
2	7.5						
3	7.5						
4	15			33.33			
5	15			33.33			
6	15			33.33			
7	5	10					
8	5	15					
9	5	15					
10	5	15					
11	5	15	33.33				
12	5	15	33.33				
13	5	15	33.33				
14					8		
15					25		
16					25		
17					6	10	
18					6	15	
19					6	15	
20					6	15	
21					6	15	33.33
22					6	15	33.33
23					6	15	33.33

13.0 Decision Analysis

13.0 Decision Analysis

There are cost risks associated with every project. The key is not to totally avoid this risk, but to be aware of its characteristics and manage it. This section presents the results of a decision analysis which was performed to provide a statistical interpretation of cost risk associated with construction and operation of the water transfer system, and to provide a basis for prudent interpretation of design decisions.

Several approaches are available for an analysis of this type. The cost and schedule implications of the approaches can vary radically, as can the usefulness of the results. Traditional deterministic analyses present only average or "expected" results. Outside of simple sensitivity cases, this approach gives the Owner and designer no indication of potential variability in cost. This omission of information associated with the quality of the design may indicate an advantage for an alternative that would not exist if the full spectrum of possibilities were known.

The probabilistic approaches to risk assessment, such as Monte Carlo analysis, have avoided this narrow view of design quality, and have been successful in quantifying full exposure and opportunity parameters. The downfall of this approach, however, has traditionally been long development times and high costs. The custom nature of the solutions have also made subsequent modifications difficult.

The approach used in this study maintains the features of the deterministic models, but still captures the full probabilistic nature of the elements, and presents a full quality assessment of the design. A traditional EXCEL spreadsheet was constructed to represent the framework and relationships of the technical and financial elements. The spreadsheet represents a fully functional deterministic analysis of the design and financial elements. Through use of a commercial overlay or "add-in" program, the deterministic elements of the spreadsheet were then replaced with probability density functions that reflect each member's full probabilistic variability and quality characteristics. The resulting spreadsheet has almost the full power of a custom built Monte Carlo simulator, and presents not only an "average" result, but the full representation of an Owner's cost risk and opportunity characteristics. The probability density functions allow quantifications of cost risk on selected parameters: pipelines, tunnels, pumping plants, power generation/pressure control facilities, water treatment facilities, brine disposal, environmental permitting and mitigation, total capital cost, and annual costs for all corridors and transfer volumes. For each possible output, an associated probability is provided, and risk exposure can be determined

Each model (300,000 AF; 400,000 AF; and 500,000 AF) consists of 45 sheets in an EXCEL workbook. Of the 45 sheets, 36 were required for the tunnel cost estimate to estimate geotechnical variability. This is appropriate since the tunnels represent a large portion of the cost uncertainty

Two types of probability density functions were used: uniform and triangular. The uniform density function is defined by the lowest value considered possible and the highest value considered possible, where every value in between is equally likely to happen. The triangular density function is defined by the lowest value possible, the highest value possible, and the most likely value. The most likely value was generally the value used in the project cost estimates developed separately from the decision analysis. With the triangular density function, values are more likely to be grouped toward the most likely value. The probability of obtaining a particular value lessens as the low or high values are approached with a zero probability of falling outside the range. Highest possible and lowest possible values need not be symmetrical around the most likely value. The choice of uniform or triangular probability density function for a particular cost component was the decision of the Black & Veatch project team's expert in the particular area. The choice was based on the expert's perception of the uncertainty of the cost component. All density function parameters are contained in Appendix B.

The capital cost and annual costs for Corridors 3A, 3B, 5A, and 5C were evaluated as part of the decision analysis. Stage 1 development of Corridor 1A (CRA expansion) was not included in the decision analysis because of the wide range of estimated costs which reflects the cost sensitivity of the large and complex CRA system to existing hydraulic conditions. Additional design evaluations would be appropriate to refine the system hydraulic conditions and to more accurately estimate Stage 1 development costs. A reduced annual transfer capability should also be evaluated.

Probability distributions were assigned to cost estimate line items representing significant cost. The line items where distributions were assigned are as follows:

1. Pipelines (Capital)
   - Pipeline Cost, $/ft
   - Installation/Welding/Joints, $/ft
   - Open - Cut Excavation, $/ft
   - Open - Cut Backfill, $/ft
   - Shored Excavation, $/ft
   - Shored Backfill, $/ft
   - Appurtenances, $/ft
   - Fault Crossing, $
   - Highway Crossing, $/ft
   - Railroad Crossing, $/ft
   - River Crossing, $/ft
   - Surface/Utilities, $/ft
   - Contingency, %

2. Tunnels (Capital)
   - Production Rate, ft/day
   - Install Steel Lining Cost, $/ft
   - Sets at 4' OC, ft
   - HV Sets at 4' OC, ft
   - HV Sets at 2' OC, ft
   - High Water Inflow, ft
   - Probe Drill, ft
   - Grout Water, ft
   - Concrete Lining, ft
   - 0.50" Steel Lining, ft
   - 1.00" Steel Lining, ft
   - High Temperature, ft
   - Contingency, %
3. Pumping Plants (Capital)
   - Reinforced Concrete, $/cu yd
   - Pump, $/pump
   - Motor, $/motor
   - Contingency, %
4. Power Generation/Pressure Control Facilities (Capital)
   - Reinforced Concrete, $/cu yd
   - Turbine, $/turbine
   - Generator, $/generator
   - Contingency, %
5. Water Treatment (Capital)
   - RO Equipment
   - RO Building
   - RO Installation
   - Brine Disposal
6. Environmental Permitting and Mitigation (Capital)
   - Environmental Permitting, $
   - Environmental Mitigation, $
7. Annual Costs
   - Cost of Energy
   - Water Treatment

Although the probability distributions account for selected parameter variability, contingency is still a nonzero value. The technical paper "Estimating Contingencies," Civil Engineering Magazine, Joe Sperry, April 1988 was used as a basis for estimating the distribution for contingency. In his paper, Mr. Sperry defines five major elements that compose contingency:

- Conceptual level contingency (0% to +10%)
- Bid contingency (5% to 10%).
- Design contingency (3% to 10%).
- Competition contingency (-5% to +10%).
- Geotechnical contingency (5% to 100%).

A probability distribution was assigned to account for conceptual level, bid, and design contingencies for pipeline, tunnels, pumping plants, and hydro facilities

Monte Carlo simulations were run consisting of 5,000 trials. This value was chosen because it provided values for the standard error of the mean that were below

0.5 percent of the expected value. For each trial, the simulator selects a value for each parameter with a distribution assigned to it. The selection is based on the type of distribution assigned to the parameter. The simulator then recalculates the workbook and proceeds to the next trial. After the simulation finishes, the accounting routine generates a percentile table based on the results of the 5,000 trials. The estimated cost variability resulting from the simulations are presented as probability of nonexceedance tables (Tables 13-1 to 13-6). For example, the 80 percent line within each table represents the value where there is an 80 percent probability that the cost will be below the specified value based on the assumptions stated in Appendix B. Expanded results of the simulations are contained in Appendix C.

The results show the capital cost estimates are at the upper portion of the percentile curve, and the annual costs are approximately at the 70th percentile. Based on the results of the decision analysis, the estimated ranges of capital and annual costs developed in the feasibility-level evaluations are considered reasonable and appropriate. The decision of how much risk coverage is necessary is subjective and is based on the Owners "comfort zone." Therefore, no interpretation of the results has been made.

Table 13-1 Capital plus Indirect Costs - 300,000 AF*				
Percentile	3A	3B	5A	5C
0%	1,564,322	1,288,614	1,263,629	1,141,877
5%	1,652,745	1,346,635	1,348,318	1,217,693
10%	1,674,055	1,358,913	1,364,905	1,230,367
15%	1,685,015	1,366,772	1,376,088	1,240,336
20%	1,695,630	1,374,193	1,384,356	1,247,199
25%	1,704,166	1,379,999	1,391,694	1,254,075
30%	1,712,512	1,384,820	1,398,744	1,259,808
35%	1,720,238	1,389,981	1,405,753	1,265,401
40%	1,727,937	1,394,503	1,412,140	1,271,408
45%	1,735,295	1,399,303	1,417,959	1,276,685
50%	1,742,164	1,403,961	1,425,004	1,281,617
55%	1,749,347	1,408,333	1,431,769	1,286,740
60%	1,757,014	1,413,032	1,438,068	1,291,173
65%	1,765,580	1,418,854	1,445,723	1,296,219
70%	1,773,864	1,423,682	1,453,490	1,302,115
75%	1,784,003	1,429,505	1,461,968	1,307,899
80%	1,794,833	1,435,990	1,473,472	1,314,281
85%	1,807,916	1,443,565	1,486,793	1,321,483
90%	1,823,648	1,453,035	1,501,618	1,330,866
95%	1,848,999	1,469,433	1,525,241	1,345,349
100%	1,989,076	1,553,098	1,639,841	1,425,893

* Costs are in January 1996 $1,000

Table 13-2 Capital plus Indirect Costs - 400,000 AF*				
Percentile	3A	3B	5A	5C
0%	1,672,044	1,439,752	1,372,760	1,333,179
5%	1,784,687	1,521,432	1,458,999	1,406,051
10%	1,802,543	1,535,162	1,474,895	1,420,318
15%	1,815,433	1,544,495	1,488,368	1,431,167
20%	1,826,316	1,552,180	1,497,660	1,440,333
25%	1,835,544	1,558,565	1,505,657	1,448,887
30%	1,843,778	1,564,522	1,513,173	1,456,084
35%	1,851,261	1,569,927	1,519,988	1,462,689
40%	1,859,562	1,575,734	1,527,027	1,468,489
45%	1,867,253	1,581,356	1,534,089	1,474,255
50%	1,874,924	1,586,624	1,540,584	1,479,632
55%	1,883,226	1,591,896	1,548,052	1,485,780
60%	1,890,852	1,596,776	1,555,604	1,491,797
65%	1,899,207	1,602,111	1,562,877	1,498,378
70%	1,908,600	1,607,842	1,570,643	1,505,345
75%	1,918,859	1,614,197	1,579,367	1,512,846
80%	1,929,400	1,621,934	1,589,610	1,521,420
85%	1,942,927	1,630,669	1,601,962	1,530,359
90%	1,958,268	1,641,227	1,617,718	1,540,147
95%	1,982,077	1,656,676	1,640,389	1,557,874
100%	2,135,357	1,732,629	1,779,941	1,671,915

* Costs are in January 1996 $1,000

Table 13-3 Capital plus Indirect Costs - 500,000 AF*				
Percentile	3A	3B	5A	5C
0%	1,859,413	1,651,334	1,506,559	1,577,150
5%	1,939,858	1,718,039	1,585,524	1,673,423
10%	1,959,326	1,732,995	1,603,229	1,690,983
15%	1,972,430	1,743,768	1,615,315	1,704,842
20%	1,983,523	1,752,905	1,624,972	1,715,218
25%	1,994,063	1,760,034	1,633,671	1,724,113
30%	2,003,126	1,766,427	1,642,508	1,731,509
35%	2,011,991	1,772,765	1,649,640	1,739,548
40%	2,019,792	1,778,746	1,656,374	1,745,722
45%	2,027,649	1,784,085	1,662,921	1,753,999
50%	2,035,297	1,790,204	1,670,149	1,761,512
55%	2,043,501	1,795,961	1,677,172	1,769,117
60%	2,052,164	1,801,825	1,685,021	1,775,686
65%	2,059,989	1,807,402	1,692,741	1,782,597
70%	2,068,275	1,814,523	1,701,257	1,790,146
75%	2,078,848	1,821,432	1,710,857	1,798,918
80%	2,091,113	1,829,359	1,720,604	1,808,273
85%	2,103,096	1,838,311	1,731,913	1,819,285
90%	2,119,979	1,849,603	1,747,341	1,832,773
95%	2,144,879	1,866,041	1,770,473	1,854,903
100%	2,292,948	2,008,682	1,908,458	1,968,505

* Costs are in January 1996 $1,000

Table 13-4 Annual Costs - 300,000 AF*				
Percentile	3A	3B	5A	5C
0%	35,330	45,143	37,121	47,388
5%	38,403	48,668	40,297	51,037
10%	39,043	49,449	40,998	51,844
15%	39,544	49,974	41,496	52,407
20%	39,943	50,443	41,911	52,897
25%	40,291	50,826	42,258	53,289
30%	40,614	51,187	42,589	53,655
35%	40,880	51,510	42,881	53,991
40%	41,175	51,847	43,167	54,356
45%	41,428	52,136	43,437	54,667
50%	41,689	52,439	43,697	54,990
55%	41,946	52,752	43,980	55,297
60%	42,208	53,058	44,247	55,621
65%	42,512	53,363	44,551	55,949
70%	42,814	53,757	44,875	56,350
75%	43,162	54,135	45,226	56,756
80%	43,579	54,674	45,675	57,312
85%	44,100	55,367	46,242	58,046
90%	44,878	56,602	47,113	59,523
95%	46,579	58,949	49,021	62,004
100%	51,748	65,213	54,422	68,571

* Costs are in January 1996 $1,000

Table 13-5 Annual Costs - 400,000 AF*				
Percentile	3A	3B	5A	5C
0%	46,490	58,736	48,844	61,732
5%	50,583	63,430	53,076	66,595
10%	51,442	64,473	54,011	67,671
15%	52,105	65,173	54,675	68,413
20%	52,639	65,802	55,224	69,070
25%	53,101	66,310	55,685	69,593
30%	53,532	66,789	56,126	70,082
35%	53,889	67,221	56,519	70,529
40%	54,280	67,667	56,896	71,016
45%	54,623	68,051	57,258	71,430
50%	54,966	68,457	57,605	71,860
55%	55,306	68,875	57,980	72,273
60%	55,659	69,281	58,337	72,700
65%	56,064	69,689	58,745	73,138
70%	56,468	70,214	59,173	73,671
75%	56,925	70,716	59,641	74,215
80%	57,481	71,436	60,238	74,955
85%	58,183	72,354	60,994	75,935
90%	59,223	74,004	62,153	77,904
95%	61,491	77,127	64,701	81,211
100%	68,385	85,482	71,899	89,963

* Costs are in January 1996 $1,000

Table 13-6 Annual Costs - 500,000 AF*				
Percentile	3A	3B	5A	5C
0%	57,625	72,328	60,569	76,079
5%	62,738	78,192	65,857	82,156
10%	63,812	79,496	67,023	83,500
15%	64,641	80,372	67,853	84,428
20%	65,306	81,159	68,540	85,249
25%	65,883	81,791	69,112	85,901
30%	66,422	82,391	69,669	86,514
35%	66,868	82,928	70,157	87,069
40%	67,357	83,487	70,631	87,680
45%	67,785	83,970	71,081	88,198
50%	68,214	84,477	71,513	88,734
55%	68,639	84,997	71,983	89,250
60%	69,075	85,506	72,430	89,784
65%	69,585	86,014	72,938	90,331
70%	70,089	86,669	73,476	90,998
75%	70,664	87,297	74,057	91,677
80%	71,356	88,188	74,805	92,599
85%	72,235	89,345	75,742	93,829
90%	73,539	91,417	77,200	96,289
95%	76,375	95,311	80,384	100,422
100%	84,984	105,752	89,379	111,358

* Costs are in January 1996 $1,000